European Commission

Common Implementation Strategy for the Water Framework Directive (2000/60/EC)

Guidance document n.º 3

Analysis of Pressures and Impacts

COMMON IMPLEMENTATION STRATEGY FOR THE WATER FRAMEWORK DIRECTIVE (2000/60/EC)

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Analysis of Pressures and Impacts

Produced by Working Group 2.1 - IMPRESS

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Foreword

The EU Member States, Norway and the European Commission have jointly developed a common strategy for supporting the implementation of the Directive 2000/60/EC establishing a framework for Community action in the field of water policy (the Water Framework Directive). The main aim of this strategy is to allow a coherent and harmonious implementation of this Directive. Focus is on methodological questions related to a common understanding of the technical and scientific implications of the Water Framework Directive.

One of the main short-term objectives of the strategy is the development of non-legally binding and practical Guidance Documents on various technical issues of the Directive. These Guidance Documents are targeted to those experts who are directly or indirectly implementing the Water Framework Directive in river basins. The structure, presentation and terminology is therefore adapted to the needs of these experts and formal, legalistic language is avoided wherever possible.

In the context of the above-mentioned strategy, an informal working group dedicated to the identification of pressures and assessment of impacts within the characterisation of water bodies according to Article 5 of the Directive was set up in October 2001 and named IMPRESS. Germany and the United Kingdom have joint responsibility for the project management and secretariat of the working group, which is composed of technical experts from governmental and non-governmental organisations.

The present Guidance Document is the outcome of this working group. It contains the synthesis of the output of the IMPRESS group activities and discussions that have taken place since the official launch of IMPRESS in October 2001. It builds on the input and feedback from a wide range of experts and stakeholders that have been involved throughout the process of Guidance development through meetings, workshops or electronic communication media, without binding them in any way to its content.

We, the water directors of the European Union, Norway, Switzerland and the countries applying for accession to the European Union, have examined and endorsed this Guidance during our informal meeting under the Danish Presidency in Copenhagen (21/22 November 2002). We would like to thank the participants of the Working Group and, in particular, the leaders, Isobel Austin and Volker Mohaupt, for preparing this high quality document.

We strongly believe that this and other Guidance Documents developed under the Common Implementation Strategy will play a key role in the process of implementing the Water Framework Directive.

This Guidance Document is a living document that will need continuous input and improvements as application and experience build up in all countries of the European Union and beyond. We agree, however, that this document will be made publicly available in its current form in order to present it to a wider public as a basis for carrying forward ongoing implementation work.

Moreover, we welcome that several volunteers have committed themselves to test and validate this and other documents in the so-called pilot river basins across Europe during 2003 and 2004 in order to ensure that the Guidance is applicable in practice.

We also commit ourselves to assess and decide upon the necessity for reviewing this document following the pilot testing exercises and the first experiences gained in the initial stages of the implementation.

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Overview / Executive Summary

WHAT IS THE PURPOSE OF THIS GUIDANCE DOCUMENT?

This document aims at guiding experts and stakeholders in the implementation of the Directive 2000/60/EC establishing a framework for Community action in the field of water policy (the Water Framework Directive – "the Directive"). It focuses on the analysis of pressures and impacts within the characterisation of water bodies according to Article 5 in the broader context of the development of integrated river basin management plans as required by the Directive.

TO WHOM IS THIS GUIDANCE DOCUMENT ADDRESSED?

If this is your task, we believe the Guidance will help you in doing the job, whether you are:

- Undertaking the pressures and impacts analysis yourself;
- Leading and managing experts undertaking the pressures and impacts analysis;
- Participating as a stakeholder in the assessment process;
- Using the results of the pressures and impacts analysis for aiding decision making and supporting the development of river basin management plans; or
- Reporting on the pressures and impacts analysis to the European Commission as required by the Directive.

WHAT CAN YOU FIND IN THIS GUIDANCE DOCUMENT?

Common understanding about pressures and impacts in the Water Framework Directive (Chapter 2)

- What is the role of the analysis of pressures and impacts within the implementation process of the directive?
- How the analysis contributes to the characterisation of water bodies, which has to be fulfilled according to Article 5 of the Directive, and how this analysis feeds into the development of monitoring programmes, river basin management plans and programmes of measures;
- What are the key terms of the analysis (e.g. significant pressures, water bodies at risk of failing the Directive's objectives)?
- What are the Directives objectives?

General approach for the analysis of pressures and impacts (Chapter 3)

- What is the overall approach and what are the key working steps proposed to undertake the analysis?
- Which are the methods proposed for surface waters to:
  - Identify driving forces, pressures and significant pressures?
  - Assess susceptibility of water bodies to pressures and the severity of impacts?
  - Evaluate the risk of failing objectives?
- Which are the methods proposed for groundwater to:

- Undertake the initial characterisation?
- Undertake the further characterisation for 'at risk' groundwater bodies and bodies that cross the boundaries of member states?

The Toolbox (Chapter 4)

- Which specific tools, such as data, classification systems and models, are available to aid the analysis of pressures and impacts?

Sources of data and information (Chapter 5)

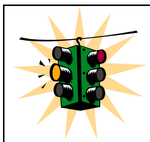
- Where do you find the information and data that will be required to undertake the analysis described in Section 3 or to support the tools mentioned in Section 4?

Examples of current practice (Chapter 6)

- What examples are available of current good practice in respect of at least one aspect of the analysis?

The methodology from this Guidance Document must be adapted to regional and national circumstances

The Guidance Document proposes an overall process and associated key steps. Due to the diversity of circumstances within the European Union, the way to undertake the analysis will vary from one river basin to the next. This proposed methodology will therefore need to be tailored to specific circumstances.



Look out!

What you will not find in this Guidance Document

The Guidance Document focuses on the "review of the impacts of human activity on the status of surface waters and on groundwater" according to Article 5 and Annex II (1.4, 1.5 and 2.). This then helps to develop River Basin Management Plans and Programmes of Measures. The Guidance focuses specifically on the 2004 requirements of the Directive. The Guidance does not focus on:

- How to designate heavily modified water bodies (see WFD CIS Guidance Document No 4 on Identification and Designation of Artificial and Heavily Modified Water Bodies);
- How to design monitoring programmes (see WFD CIS Guidance Document No 7 on Monitoring);
- How to develop any measure needed to achieve the objectives of the Directive (see WFD CIS Guidance Document No 9 on Best Practices in River Basin Planning).

1. Implementing the Directive: Setting the scene

This Section introduces the overall context for the implementation of the Water Framework Directive (WFD) and the initiatives that led to the production of this Guidance Document.

1.1 December 2000: A Milestone for Water Policy

A long negotiation process
December 22, 2000, will remain a milestone in the history of water policies in Europe: on that date, the WFD (or the Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy) was published in the Official Journal of the European Communities and thereby entered into force.

The WFD is the result of a process of more than five years of discussions and negotiations between a wide range of experts, stakeholders and policy makers. This process has stressed the widespread agreement on key principles of modern water management that form today the foundation of the WFD.

1.2 The Water Framework Directive: new challenges in EU water policy

What is the purpose of the Directive?
The WFD establishes a framework for the protection of all waters (including inland surface waters, transitional waters, coastal waters and groundwater) which, according to Article 1:

- Prevents further deterioration of, protects and enhances the status of water resources;
- Promotes sustainable water use based on long-term protection of water resources;
- Aims at enhancing protection and improvement of the aquatic environment through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;
- Ensures the progressive reduction of pollution of groundwater and prevents its further pollution; and
- Contributes to mitigating the effects of floods and droughts.

…and what is the key objective?
Overall, the Directive aims at achieving *good water status* for all waters by 2015.

What are the key actions that Member States need to take?
- To identify the individual river basins lying within their national territory and assign them to individual River Basin Districts (RBDs) and identify competent authorities by 2003 (*Article 3, Article 24*);
- To characterise river basin districts in terms of pressures, impacts and economics of water uses, including a register of protected areas lying within the river basin district, by 2004 (*Article 5, Article 6, Annex II, Annex III*);

- To carry out, jointly and together with the European Commission, the intercalibration of the ecological status classification systems by 2006 (*Article 2 (22), Annex V*);
- To make operational the monitoring networks by 2006 (*Article 8*);
- Based on sound monitoring and the analysis of the characteristics of the river basin, to identify by 2009 a programme of measures for achieving the environmental objectives of the WFD cost-effectively (*Article 11, Annex III*);
- To produce and publish River Basin Management Plans (RBMPs) for each RBD including the designation of heavily modified water bodies, by 2009 (*Article 13, Article 4.3*);
- To implement water pricing policies that enhance the sustainability of water resources by 2010 (*Article 9*);
- To make the measures of the programme operational by 2012 (*Article 11*);
- To implement the programmes of measures and achieve the environmental objectives by 2015 (*Article 4*).

Member States may not always be able to achieve good water status for all water bodies within a RBD by 2015, for reasons of technical feasibility, disproportionate costs or natural conditions. Under such conditions, which must be specifically explained in the relevant RBMP, the WFD offers the possibility to Member States to engage into two further six-year cycles of planning and implementation of measures (i.e. to 2027). Where failure to achieve objectives is constrained by natural conditions, the period may be extended beyond 2027.

Changing the management process – information, consultation and participation

Article 14 of the Directive specifies that Member States shall encourage the active involvement of all interested parties in the implementation of the Directive and development of river basin management plans. Also, Member States will inform and consult the public, including users, in particular for:

- The timetable and work programme for the production of river basin management plans and the role of consultation at the latest by 2006;
- The overview of the significant water management issues in the river basin at the latest by 2007;
- The draft river basin management plan, at the latest by 2008.

Integration: a key concept underlying the Water Framework Directive

The central concept to the Water Framework Directive is the concept of *integration* that is seen as key to the management of water protection within the river basin district:

- **Integration of environmental objectives**, combining quality, ecological and quantity objectives for protecting highly valuable aquatic ecosystems and ensuring a general good status of other waters;
- **Integration of all water resources**, combining fresh surface water and groundwater bodies, wetlands, coastal water resources **at the river basin scale**;
- **Integration of all water uses, functions and values** into a common policy framework, i.e. investigating water for the environment, water for health and human consumption, water for economic sectors, transport, leisure, water as a social good;
- **Integration of disciplines, analyses and expertise,** combining hydrology, hydraulics, ecology, chemistry, soil sciences, technology engineering and economics to assess current pressures and impacts on water resources and identify measures for achieving the environmental objectives of the Directive in the most cost-effective manner;
- **Integration of water legislation into a common and coherent framework.** The requirements of some old water legislation (e.g. the Fishwater Directive) have been reformulated in the Water Framework Directive to meet modern ecological thinking. After a transitional period, these old Directives will be repealed. Other pieces of legislation (e.g. the Nitrates Directive and the Urban Wastewater Treatment Directive) must be co-ordinated in river basin management plans where they form the basis of the programmes of measures;
- **Integration of all significant management and ecological aspects** relevant to sustainable river basin planning including those which are beyond the scope of the Water Framework Directive such as flood protection and prevention;
- **Integration of a wide range of measures, including pricing and economic and financial instruments, in a common management approach** for achieving the environmental objectives of the Directive. Programmes of measures are defined in **River Basin Management Plans** developed for each river basin district;
- **Integration of stakeholders and the civil society in decision making,** by promoting transparency and information to the public, and by offering an unique opportunity for involving stakeholders in the development of river basin management plans;
- **Integration of different decision-making levels that influence water resources and water status,** be local, regional or national, for an effective management of all waters;
- **Integration of water management from different Member States,** for river basins shared by several countries, existing and/or future Member States of the European Union.

1.3 What is being done to support implementation?

Activities to support the implementation of the WFD are under way in both Member States and in countries candidate for accession to the European Union. Examples of activities include consultation of the public, development of national guidance, pilot activities for testing specific elements of the Directive or the overall planning process, discussions on the institutional framework or launching of research programmes dedicated to the WFD.

May 2001 – Sweden: Member States, Norway and the European Commission agreed a Common Implementation Strategy (CIS).

The main objective of this strategy is to provide support to the implementation of the WFD by developing coherent and common understanding and guidance on key elements of this Directive. Key principles in this common strategy include sharing information and experiences, developing common methodologies and approaches, involving experts from candidate countries and involving stakeholders from the water community.

In the context of this common implementation strategy, a series of working groups and joint activities have been launched for the development and testing of non-legally binding Guidance (see Annex I). A strategic co-ordination group oversees these working groups and reports directly to the water directors of the European Union and Commission that play the role of overall decision making body for the CIS.

The IMPRESS working group
In the context of this strategy, a working group dedicated to the identification of pressures and assessment of impacts within the characterisation of water bodies according to Article 5 of the Directive has been set up. The main (short-term) objective of this working group, launched in October 2001 and named IMPRESS, was the development of a non-legally binding and practical Guidance Document on this topic within the WFD. Germany and the United Kingdom have joint responsibility for the project management and secretariat of the working group, which is composed of technical experts from governmental and non-governmental organisations.

To ensure an adequate input and feedback during the Guidance development phase from a wider audience, and to evaluate earlier versions of the Guidance Document, the IMPRESS group has organised several discussions and feedback events such as meetings and workshops.

Developing the Guidance Document: an interactive process
Within a very short time period, a large number of experts and stakeholders have been involved at varying degrees in the development of this Guidance Document. The process for their involvement has included the following activities:

- **Regular meetings** of the 40-plus experts and stakeholder members of IMPRESS;
- **Regular interactions** with experts from other working groups of the Common Implementation Strategy, mainly those dealing with economic

analysis, designation of heavily modified water bodies, reference conditions, and monitoring.

You can contact the experts involved in the IMPRESS activities
The list of IMPRESS members with full contact details can be found in Annex III of this guidance. If you need assistance with your own activities, contact a member from IMPRESS in your country.

2. Analysis of Pressures and Impacts in the Water Framework Directive – Common Understanding

2.1 Recall of WFD requirements

2.1.1 Requirements in relation to pressure and impact analysis

The previous Chapter has made clear the *purpose* of the WFD, and the importance of *integration* in achieving its objectives. The necessity to analyse pressures and impacts is stated in Article 5 of the WFD which requires, for each river basin district:

- An analysis of its characteristics;
- A review of the impact of human activity on the status of surface waters and groundwater; and.
- An economic analysis of water use.

This Guidance addresses the second of these requirements, but must be fully integrated with the economic analysis, for which Guidance has been prepared by the Economic Analysis working group (WATECO) (refer to WFD CIS Guidance Document No 1). The WFD requires the tasks specified under Article 5 to be completed by 2004. They will then be reviewed by 2013, and subsequently every 6 years (2019, 2025…). Given the overall purpose of the WFD, the analysis undertaken in 2004 must consider both the current condition for each water body, and a prognosis for the period to 2015. Thus the WFD is initiating an on-going process of assessment, iteration and refinement.

A specification for the impact review is contained in WFD Annex II Section 1 for surface waters, and Annex II Section 2 for groundwaters (Figure 2.1).

Surface waters

The review process is described in five parts corresponding to the sub-sections within WFD Annex II Section 1, namely:

1. Characterisation of surface water body types;
2. Ecoregions and surface water body types;
3. Establishment of type-specific reference conditions for surface water body types;
4. **Identification of Pressures;** and,
5. **Assessment of Impacts**.

This Guidance Document addresses the final two parts of this process, but clearly relates closely to both the characterisation and the establishment of reference conditions. There are two separate working groups of the CIS providing Guidance on Reference Conditions for Inland Surface Waters (REFCOND) and Typology and Classification Systems of Transitional and Coastal Waters (COAST) (refer to WFD CIS Guidance Document No.s 10 and 5, respectively).

The WFD requires information to be collected and maintained on the type and magnitude of significant anthropogenic pressures, and indicates a broad categorisation of the pressures into:

- Point sources of pollution;

- Diffuse sources of pollution;
- Effects of modifying the flow regime through abstraction or regulation; and,
- Morphological alterations.

Any other pressures, i.e. those not falling within these categories, must also be identified. In addition there is a requirement to consider land use patterns (e.g. urban, industrial, agricultural, forestry etc) as these may be useful to indicate areas in which specific pressures are located.

The impact assessment should use both information from the review of pressures, and any other information, for example environmental monitoring data, to determine the likelihood that the surface water body will fail to meet its environmental quality objectives. For bodies at risk of failing their specified objectives, it will be necessary to consider the implementation of additional monitoring and a programme of measures.

Groundwaters

A different process is described within WFD Annex II, Section 2, but this again has five parts (Figure 2.1), namely:

1. **Initial characterisation**, including identification of pressures and risk of failing to achieve objectives;
2. **Further characterisation** for at risk groundwater bodies;
3. **Review of the impact of human activity on groundwaters** for trans-boundary and at risk groundwater bodies;
4. **Review of the impact of changes in groundwater levels** for groundwater bodies for which lower objectives are to be set according to Article 4.5; and,
5. **Review of the impact of pollution on groundwater quality** for which lower objectives are to be set.

This Guidance addresses all parts of this process. The pressures identified in WFD Annex II, Sub-section 2.1 correspond to the first three of the categories identified for surface waters, namely:

- Point sources of pollution;
- Diffuse sources of pollution; and,
- Changes in water levels and flow caused by abstraction or recharge.

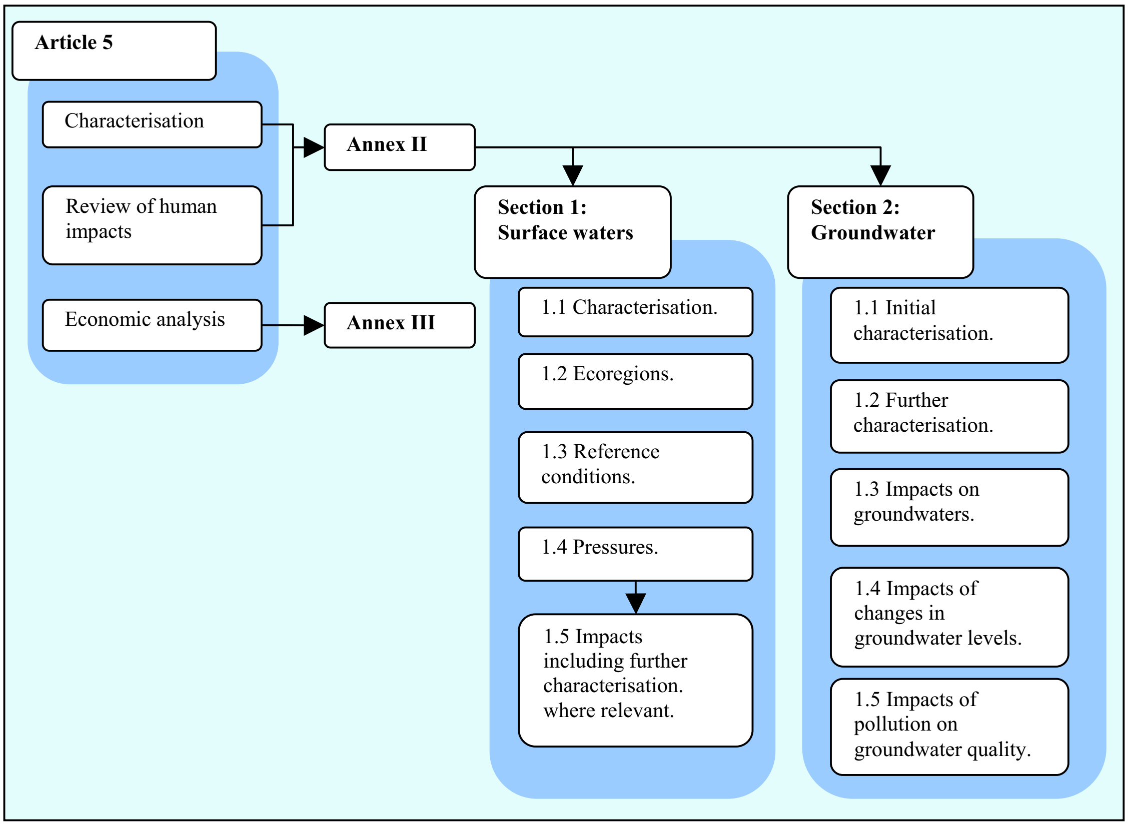


Figure 2.1 The WFD specifies requirements for impact analysis separately, and differently, for surface and groundwaters.

2.1.2 Links to other relevant requirements and related timescale

The review of pressures and impacts is only one element of the planning process, with other elements feeding into the review, or dependent on its outcome (Figure 2.2).

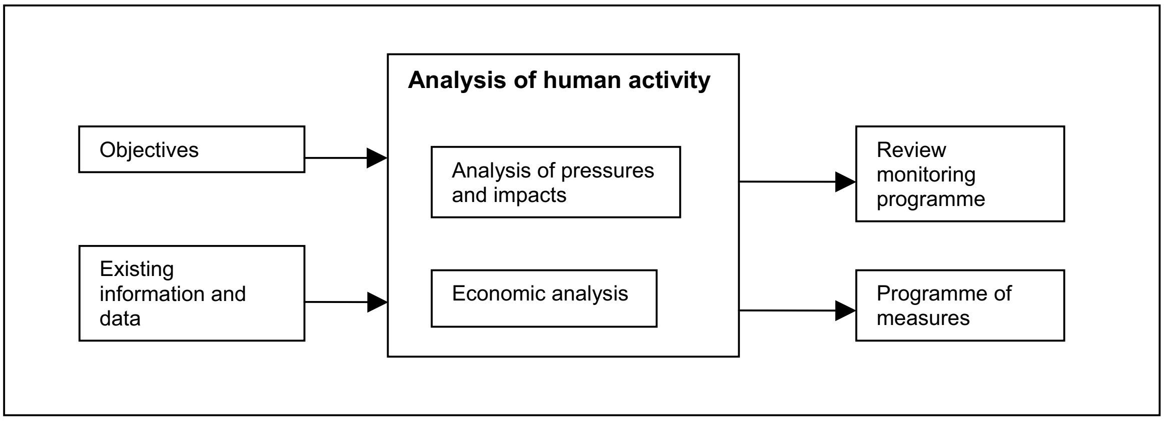


Figure 2.2 Elements of the planning process.

One of the most fundamental elements of this larger process is the setting of the environmental objectives (Article 4) since the review of pressures and impacts must identify water bodies that fail, or are at risk of failing, the specified objective. The objectives depend on both the overall objective to achieve good status by 2015, and possibly additional specific objectives that apply to *protected areas* as defined from other legislation. The objectives may also depend on the current status of the water body, since member states must, in general, prevent any deterioration in the status. The objectives are considered further in Section 2.3.

In the longer term, the achievement of the goals will be assessed through the monitoring of a water bodies' chemical and ecological state. The most important goal of the first review, required in 2004, is to understand the significant water management issues within each river basin and how they affect each individual water body. This may be considered a screening step prior to additional description and analysis at a later stage. This screening should identify issues to be addressed in the drawing up of the river basin management plan (RBMP), and it may also reveal a number of gaps in data or knowledge that should be filled during the process of drawing up the RBMP and the monitoring programme.

A factor that can affect the setting of objectives concerns the designation of a water body as artificial or heavily modified (Article 4). Guidance on such designation is available in WFD CIS Guidance Document No. 4. However, since designation of HMWBs will not be completed until 2009, the principles of the HMWB Guidance should be considered in undertaking the first pressures and impacts analysis. Indeed, the two processes should be seen as closely interacting parallel processes, and not independent activities.

The WFD establishes a number of objectives for surface waters and groundwater, and the pressures and impacts analyses must assess the risks of failing to achieve each of them. The objectives include new ecological objectives, the achievement of which may be compromised by a very wide range of pressures, including point source discharges, diffuse source discharges, water abstractions, water flow regulation, morphological alterations and artificial recharge of groundwater. These and any other pressures that could affect the status of aquatic ecosystems must be considered in the analyses.

The WFD requires the achievement of its principal objectives; good surface water status and good groundwater status, by the end of 2015 at the latest, unless Articles 4.3 – 4.7are applicable. Accordingly, the analyses of pressures and impacts must consider how pressures would be likely to develop prior to 2015 in ways that would place water bodies at risk of failing to achieve good status if appropriate programmes of measures were not designed and implemented. This will require consideration of the effects of existing legislation and forecasts of how the key economic factors that influence water uses will evolve over time, and how these changes may affect the pressures on the water environment (refer WFD CIS Guidance Document No. 3). Such forecasts should be provided by the economic analyses of water use required under Article 5. The pressures and impacts analyses will also need to identify which of the risks to the WFDs' objectives are expected to be addressed by the implementation of measures specified under other Community legislation. This information will enable the economic analyses to assess, and provide advice on, the most cost-effective combinations of measures that can be used to address the other risks to the achievement of the WFDs' objectives.

The WFDs' objective of preventing or limiting inputs of pollutants into groundwater [Article 4.1(b)(i)] does not specify which pollutants should be prevented from entry and to what extent others should be limited. It is therefore not clear how to assess the risks of failing to achieve this objective until clarification of its purposes is provided.

Such clarification may be provided in a daughter directive to be established under Article 17. This Daughter Directive is also expected to establish criteria for the identification of significant and sustained upward trends [Article 4.1(b)(iii)]. Until these criteria have been established, Member States will need to decide what constitutes a significant and sustained upward trend according to their own criteria.

The review of the pressures and impacts is required in the design of monitoring programmes which must be operational by 2006 (Article 8), and also to help develop programmes of measures which must be established by 2009, and made operational by 2012 (Article11). Article 14encourages the active involvement of all interested parties in the implementation of the WFD and requires Member States to *inform and consult the public*. Therefore, water agencies and authorities should make this review as transparent as possible. This Article specifically requires public consultation in the production of the RBMP, to which the pressures and impacts analysis makes a significant contribution.

Information sharing, consultation and public participation are requirements of the directive, and will also make implementation more effective. The Guidance Document on "Public Participation" provides further information about these forms of participation (WFD CIS Guidance Document No. 8).

Stakeholder participation is important as it can fulfil many functions, including:

- Developing a process agreed by all will increase the legitimacy of its outcome and thus facilitate an efficient and effective follow-up;
- Stakeholders can be a useful source of information and have expertise of direct use for the pressures and impact analysis (see Tables in Chapter 5);
- Survey of the public can be useful to understand how people value improvements in the environment and quality of our waters, and how far they are ready to pay for environmental improvements;
- Public involvement and the network of partners developed through participation can be useful to develop a sense of ownership over the River Basin Management Plans and may increase the effectiveness of measures taken to meet the Directive's objectives.

The Directive only specifies key dates for consultation, but rightly does not specify dates for the participation process, as this will depend on local institutions and socio-reference conditions set-up. However, it is recommended to start the participation process early (e.g. as part of the characterisation of the river basin before 2004) to improve its effectiveness.

See also Chapter 5 of this document showing who needs to get involved in carrying out and using the IMPRESS analysis.

Article 15 specifies the reporting requirements of the review undertaken under Article 5. Member states are required to provide summary reports of the reviews within three months of their completion (i.e. by March 2005 at the latest for the first review). Subsequently, reporting on these reviews will be contained in the RBMPs, which must be published first in 2009, and thereafter every six years (2015, 2021…). Therefore, from 2009 a schedule with a six-year cycle shall be established, with the review of pressures and impacts occurring two years prior to the publishing of the RBMP.

Article 6 requires that a register of *protected areas* is established by 2004, but this information is required at an earlier date to enable the review of pressures and impacts. The timescales and associated links are summarised in Table 2.1

Table 2.1 Actions and dates by which they must be achieved (note that in practice many actions must be completed within a fixed period of the completion of a prerequisite task).

Action	**Date**
Impact review completed by member states (Article 5, Article 15, Annex II)	2004
Register of protected areas established (Article 6)	2004
Summary reporting of impact review to Commission (Article 15)	2005
Monitoring programme operational (Article 8)	2006
First River Basin Management Plan completed (Article 15)	2009
Programme of measures established (Article 11)	2009
Programme of measures operational (Article 11)	2012

2.2 Key terms

While it is clear from the WFD that the impacts are the result of pressures, neither term is explicitly defined. For this reason a common understanding of the terms and the most effective approach has to be developed. In this Guidancethe widely-used Driver, Pressure, State, Impact, Response (DPSIR) analytical framework has been adopted with definitions as in Table 2.2, and illustrated using an example in Figure 2.3.

Table 2.2 The DPSIR framework as used in the pressures and impacts analysis.

Term	**Definition**
Driver	an anthropogenic activity that may have an environmental effect (e.g. agriculture, industry)
Pressure	the direct effect of the driver (for example, an effect that causes a change in flow or a change in the water chemistry)
State	the condition of the water body resulting from both natural and anthropogenic factors (i.e. physical, chemical and biological characteristics)
Impact	the environmental effect of the pressure (e.g. fish killed, ecosystem modified)
Response	the measures taken to improve the state of the water body (e.g. restricting abstraction, limiting point source discharges, developing best practice Guidance for agriculture)

It is clear from these definitions that in the analysis of *pressures* and *impacts,* it is necessary to include information on *drivers*, and changes in the *state*, but that *responses* need not be considered. The distinction made here between state and impact separates effects that are sometimes combined, or confused. One reason for this is that because many of the impacts are not easily measurable, state is often used as an indicator of, or surrogate for, impact. This is seen in many existing methodologies (e.g. quality targets and classification systems) in which physico-chemical parameters are used to quantify ecological status. While such methods imply a well-understood relationship between state and impact, in practice this is not the case, and is the subject of on-going scientific research. In addition to this uncertainty, the parameters defining ecological status will not be finally established until after the first pressure and impact review has to be completed. The approach adopted in this guidance, therefore, provides a framework for analysis that reflects current understanding of how aquatic ecosystems function, and enables future integration of specific ecological criteria.

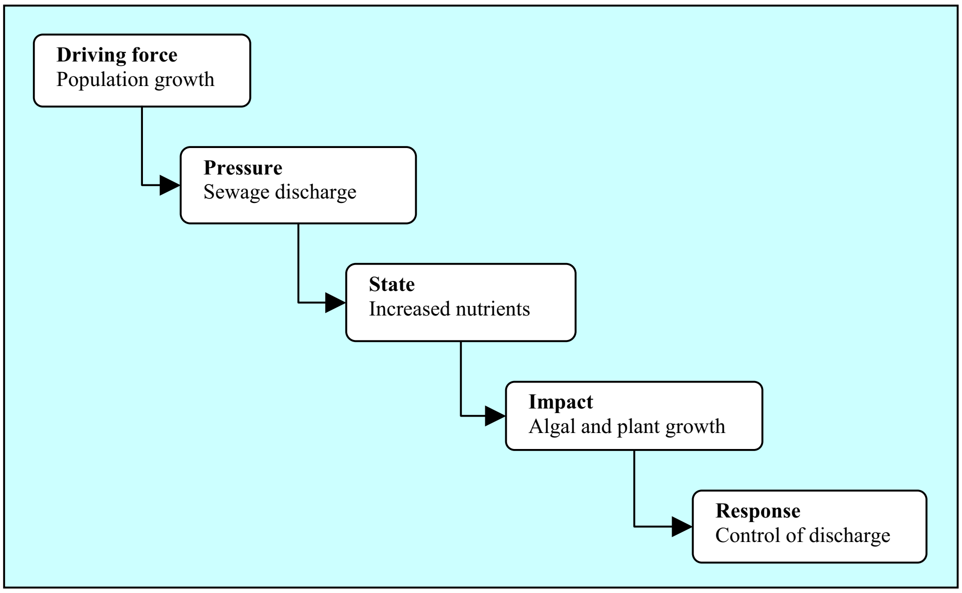


Figure 2.3 *An illustration of the DPSIR analytical framework (note that the response is not considered in the analysis of pressures and impacts described in this guidance).*

It is worth noting in the context of the DPSIR framework as described above, that objectives defined by the WFD relate to both the state and the impact, since, standards from other European water quality objective legislation relate to the concentration of pollutants in the water body (i.e. its state), while the biological elements of the WFD clearly indicate impacts.

Despite this problem of nomenclature, the meaning of the WFD is clear. If the water body fails to meet its objective, or is at risk of failing to meet its objective, then the cause of this failure (i.e. the pressure or combination of pressures) must be investigated. Thus *when the Directive states that significant pressures must be identified, this can be taken to mean any pressure that on its own, or in combination with other pressures, may lead to a failure to achieve the specified objective*. Such an interpretation introduces a scale dependence, which is considered in Section 2.3.2. It is also worth noting that the actual criterion used to assess significant pressures for both surface and groundwater is that they are *at risk of failing* to meet objectives. The process of analysing pressures and their impacts is a "risk assessment" process but in this Guidanceis always referred to as a pressures and impacts analysis.

Other terms are defined in the glossary in Annex II.

2.3 Relevant considerations

2.3.1 Water Body Definition

The requirements described above all relate to a *body of surface water*, or a *body of groundwater*. The WFD defines both of these terms, and as part of the definition notes that surface water bodies should be *discrete* but need not, for example, be a whole river, while groundwater bodies should be *distinct*. Draft Guidancehas been prepared within the CIS on the identification of discrete and distinct water bodies: *Horizontal Guidanceon the application of the term "water body" in the context of the Water Framework Directive* (WFD Guidance Document No. 2). This addresses scaling issues and the importance of defining water bodies with reference not only to water body type and morphological change, but also to pressures and impacts. In the absence of finalised definitions of water bodies, this Guidanceaddresses the *process* of pressure and impact analysis which should be independent of any outstanding issues relating to water body definition.

2.3.2 Scaling Issues

Different kinds of pressures do not impact the different water bodies at the same space and time scales. Hence the analysis of pressures must be carried out to ensure that a) the final reporting that is produced with the collected information is consistent with the WFD objectives and b) that data collection is feasible on the long term.

Most impacts cannot be monitored or even assessed directly. In many cases, their identification is derived from observation of changes in the state and the likelihood of these changes to be caused by known pressures. The correct time and space scales of data collection of both pressures and states are the most important points that make it possible to establish sound (therefore recognised as true) relationships, and consequently appropriate programmes of measures. The assessment of the relevant space and time scales is made easier when considering that a pressure results from a load exerted during a certain time over a certain target, that has a particular size. For example, the abstraction of a certain volume of water may have no impact if pumped throughout the year but be a significant pressure if taken out of a river only during the summer months.

The correct identification of pressures requires consistent identification of the relevant targets, their size and the susceptibility to being impacted. The spatial scale is derived from this identification. For practical purposes, compromises must be made to minimize the burden of data collection. Considering the many data sources that are likely to provide ad-hoc data for pressure assessment, that can be used either for surface or groundwater impact analysis, some common rules are suggested.

Regarding the temporal scale, it is important to adopt appropriate temporal scales in the pressures and impacts analysis since some pressures may result in impacts many years in the future, and some future impacts will relate to past pressures that no longer exist. However, most data sources provide yearly data. This scale may often be satisfactory to address long-term impacts. For example, large lakes or groundwater bodies are impacted by cumulative inputs lasting up to dozens of years. By contrast, river or sea-shore pollution, tourism or agricultural abstraction impacts result from peak demand on limited resources. In the latter case, the yearly data does not provide information on significant pressures over a shorter time scale.

Correctly addressing all impacts requires, with respect to time scale:

- Within-year data, indicating the annual pattern, to at least comprise the mean value, the peak value and its duration, the optimum being a monthly value,
- Long-term between-years data, if relevant, including diffuse sources to rivers (e.g., the release from sediments of toxic substances discharged through a former industrial activity).

Regarding spatial scales, the important features of data are the location, especially if the water body comprises very different components (e.g. main river channel and its tributaries, recharge area of a confined groundwater etc) that respond differently to the pressure. Pressure location can be analysed as precise information or as density information. In the first case, the relevant component of the water body is identified. In the latter, the area on which the pressure is exerted must be identified and small enough to make it possible to link the pressure to its target. For example, considering confined groundwater, the important data is the emissions on the recharge area only, not over the total extent of the water body.

These principles are further clarified in the following Chapters.

2.3.3 Different starting points

The timetable for completing the first pressures and impacts analyses and reporting their results is very short. The first analyses will therefore rely heavily on existing information on pressures and impacts and existing assessment methods. Because previous Community water legislation has been focused on pollution, the information and expertise on other pressures and their impacts is very variable between and even within Member States, depending on national legislation and policies.

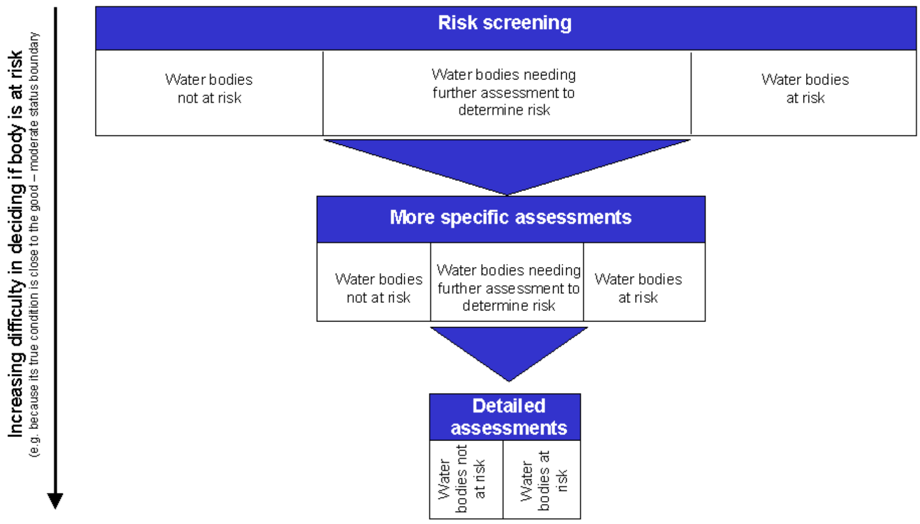


Figure 2.1 *The pressures and impacts analyses should be focused in such a way that the effort involved in assessing whether any body, or group of bodies, is at risk of failing to achieve its environmental objectives is proportionate to the difficulties involved in making that judgement.*

2.3.4 Grouping water bodies

Grouping water bodies, provided this is done on a sound scientific basis, will also be important in ensuring the most cost effective approach to the pressures and impacts analyses. The ability to group bodies will depend on the characteristics of the river basin district and the type and extent of pressures on it.

2.3.5 Taking account of uncertainty

The first pressures and impacts analyses must be complete by the end of 2004. However, the environmental conditions required to meet most of the Directive's objectives will not have been firmly defined by this date. For example, the values for the boundaries between the ecological status classes for surface waters are not expected to be finally determined until after the end of the intercalibration exercise (WFD Annex V 1.4) and the start of the monitoring programmes in 2006 (Article 8). The environmental quality standards for the priority substances, which form part of the definition of good surface water chemical status, will not be finalised until the agreement of Article 16 daughter directives. Elements of the groundwater objectives also await clarification in the Article 17 daughter directive. The confidence and precision in the estimated environmental effects of different pressure types will also be very variable, depending to a great extent on the quality of national and local information and assessment expertise. This is because consideration of many of the pressures and impacts relevant under the Water Framework Directive has not previously been required by other Community water legislation.

Member States will need to complete the first analyses using appropriate estimates for pressures and impacts but they should be aware, and take account of, the uncertainties in the environmental conditions required to meet the Directives' objectives and the uncertainties in the estimated impacts.

The consequence of these uncertainties is that Member States' judgements on which bodies are at risk, and which are not, are likely to contain more errors in the first pressures and impacts report (the 'IMPRESS' report) than will be the case in subsequent planning cycles. It will be important for Member States to be aware of the uncertainties so that their monitoring programmes can be designed and targeted to provide the information needed to improve the confidence in the assessments. Where the assessment contains significant uncertainty, those water bodies should be categorised as at risk of failing to meet their objectives. Obvious failing of pressures is not an uncertainty.

2.3.6 Understanding the objectives

So far it has been noted that pressures to be included in the analysis are those that, alone or in combination, cause impacts which prevent objectives being achieved. To do this clearly requires some understanding of the objectives, and this is addressed in this Section.

To summarise, the review of the impact of human activities has to include all environmental objectives of Article 4 WFD, which are:

- Achievement of good ecological status and good surface water chemical status;

- Achievement of good ecological potential and good surface water chemical status for artificial water bodies;
- Achievement of good groundwater status (i.e. good groundwater chemical status and good groundwater quantitative status);

and, if they lead to more stringent objectives:

- Prevention of deterioration in status of surface waters and groundwater;
- Achievement of objectives and standards for Protected Areas;
- Reversal of any significant and sustained upward trends in pollutant concentrations in groundwater; and
- Cessation of discharges of Priority Hazardous Substances into surface waters;

and, for the second review in 2013 and any following:

- Achievement of good ecological potential and good surface water chemical status for heavily modified (HMWBs).

The WFD defines four types of objective; ecological status, ecological potential, chemical status and quantitative status, but these are not all applicable to all water bodies (see Table 2.3). Groundwaters clearly have different objectives; there is no concept of ecological status, the definition of chemical status is quite different to the definition for surface waters, and uniquely for groundwaters, there is the separate assessment of quantitative status. However, as outlined below for surface waters, quantitative information is required as part of the hydromorphological assessment. Ecological potential is only applicable to surface water bodies designated as artificial or heavily modified. Prior to such designation, which need not be completed until 2009, analysis of pressures and impacts will most usually assume the criterion for a natural water body (i.e. ecological status).

The nature of the objectives are considered separately for surface and groundwaters in the following Sections. A number of general points can be made that apply to all water bodies:

I. For each of the applicable objectives the target is, generally, to achieve "good status" by 2015. Answering the question of whether a water body is at risk of failing to achieve this objective therefore involves two determinations; initially the current condition of the body needs to be evaluated, followed by an assessment of whether it is likely to achieve its objectives by 2015. For surface waters, the period until 2015 provides an opportunity to identify pressures, introduce measures to achieve the objective, and to carry out monitoring to demonstrate that it has been achieved. But, it also means that some account must be taken of changes to the pressures that occur during this period. While this is also true for groundwaters, the long residence times of water within many aquifers means that the analysis of pressures and impacts must take account of present day pressures causing problems at a future date. This issue is addressed specifically within the groundwater Section below.

II. Additional objectives may be applicable if other community legislation designates the water body as falling in a protected area; this too is discussed further below.

III. Numerical limits have not yet been set to define the boundaries in each of the different elements of status, although these will eventually be set based on the Guidance of the Reference Conditions working group and the Intercalibration study (WFD CIS Guidance Documents No.'s 10 and 6 respectively). In the meantime expert judgement within the competent authority must be used to set interim values for use in the first round of assessments. It is recommended that where possible the interim values should be to reasonable estimates of the final values. Adopting values that are too strict could lead to unnecessary monitoring and measures, while adopting values that are too lax will delay necessary actions. Where expert judgement is used it should be open and transparent.

IV. While this Guidance describes the process of pressure and impacts analysis against these objectives, it should be noted that the WFD also provides for circumstances where there may be exemptions or relaxation of the provisions (Article 4, parts 6 and 7). In outline, these refer to temporary deterioration in the status, and deterioration caused by new sustainable development, respectively. However, such circumstances should be identified as part of the pressures and impacts analysis, and not taken as an *a priori* rationale for by-passing the analysis.

Table 2.3 Objectives applicable to different water body types.

	River	**Lake**	**Transitional water**	**Coastal water**	**Heavily modified or artificial**	**Groundwater**
Ecological status	✓	✓	✓	✓	×	×
Ecological potential	×	×	×	×	✓	×
Surface water chemical status	✓	✓	✓	✓	✓	✓
Ground water chemical status	×	×	×	×	×	✓
Groundwater quantitative status	×	×	×	×	×	✓

Objectives for surface waters

Ecological status and ecological potential both contain three elements; these are biological, chemical and physical (or physico-chemical), and hydromorphological. The overall ecological status is determined by the lower of the biological and chemical components. Note that the objective for surface waters is not just that good status is achieved, but also that no deterioration of quality occurs. Thus, if ecological status of a water body is currently assessed as "high", it must not deteriorate to "good" in the future.

Biological elements

This is again sub-divided into three components; flora, benthic invertebrates, and fish fauna (this component is excluded in coastal waters). Together these are used to place the water body in one of five classes; high, good, moderate, poor and bad. The process by which this classification is achieved is addressed by the REFCOND (refer to WFD CIS Guidance Document No. 10) and Intercalibration working groups (refer to WFD CIS Guidance Document No. 6) of the CIS. Generally high is "undisturbed" or "nearly undisturbed", good indicates "slight disturbance", moderate indicates "moderate disturbance", poor indicates "major alterations", and bad indicates "severe alterations".

Once the process is defined, the analysis of monitored data will allow the classification of the water body, and may trigger the requirement to investigate why the water body fails to meet its objective. While this is probably achievable, the reverse is far more problematic, i.e. it is likely to be much more difficult to say if a change in chemical or hydromorphological status will cause a downgrading in biological status (for example, the link between nutrient status and the abundance of fish is generally not well understood). One exception to this is for a massive exceedence (i.e. greatly beyond the built in safety factors) of a limit for a priority substance which has a direct toxic effect on an indicator species used in the biological assessment.

Chemical and physico-chemical elements
Two components, general and specific pollutants, are recognised (see Table 2.4). While for specific pollutants, environmental quality standards can be set (the WFD provides guidance), numerical limits do not exist for the general components. As noted for the biological elements, the relationship between these general aspects of water quality and biological status is poorly understood.

Table 2.4 Components of the chemical and physico-chemical element of the ecological assessment

Component	Sub-components	Class	Definition
General	Thermal conditions Oxygen conditions Salinity Acidification status Nutrients status Transparency (lakes only)	High Good Moderate	Totally or nearly totally undisturbed. With levels established to ensure functioning of ecosystems to achieve biological elements. Conditions consistent with the achievement specified for biological elements.
Specific pollutants (priority substances and other substances identified as being discharged in significant quantities)	Synthetic	High Good Moderate	Below detection limits. Within EQS limits. Conditions consistent with the achievement specified for biological elements.
	Non-synthetic	High Good Moderate	Below normal background level. Within EQS limits. Conditions consistent with the achievement specified for biological elements.

Hydromorphological elements
The components used in this assessment vary between water body type, but the classification is as for the general chemical elements (i.e. high, good and moderate) with similar definitions of the classes (Table 2.4). The hydromorphological elements are not used in the determination of ecological status, but could be the cause of the failure to achieve good or high ecological status.

Implications for the analysis of pressures and impacts for surface waters
While it necessary for the analysis to consider effects of pressures on the biological elements, there will be uncertainties in the links between biology, chemistry and hydromorphology. Member States should take account of these uncertainties in undertaking the assessments. Since the classification of the chemical and hydromorphological elements is linked to the biological condition (see Table 2.4), but without critical values being defined. What will be required, in the short term at least, is a set of numerical values for the general chemical components that are

deemed satisfactory by expert judgement, in a particular region or eco-region, to indicate risk of failing to achieve good ecological status. This Guidance will not propose such values, but by assuming they exist can describe methods of analysis, and draw attention to existing examples of such classifications.

Heavily modified water bodies and the timetable
For water bodies designated as artificial or heavily modified, the principal objective is to achieve good ecological potential rather than good ecological status. Water bodies intended to be designated as heavily modified must be subject to two risk assessments: (1) an assessment of the risk of failing good ecological status because of physical alterations, and (2) an assessment of the risk of failing good ecological potential. However, there are serious practical difficulties in completing both these assessments for all potential heavily modified water bodies before the end of 2004. Note that only water bodies failing good ecological status because of substantial physical alterations can be considered for designation as heavily modified water bodies under Article 4.3. The first pressures and impacts analyses will therefore identify potential heavily modified water bodies.

Objectives for groundwaters.

For groundwaters the objectives are essentially:

1. To implement measures to prevent or limit the input of pollutants into groundwater and to prevent the deterioration of the status of the groundwater body (groundwater status consists of two parts; quantitative status and chemical status and the overall status of groundwater is taken to be the poorer of the two);
2. To protect, enhance and restore all bodies of groundwater, and ensure a balance between abstraction and recharge of groundwater, with the aim of achieving good groundwater status by 2015 in accordance with the provisions laid down in Annex V;
3. To reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity in order to progressively reduce pollution of groundwater.

If a groundwater body currently has good status but it is thought that pressures may cause its status to be rendered poor by 2015, then the body is “at risk” and will require further characterisation. It should be noted that a body currently determined to have poor status will automatically be “at risk”.

Article 17 of the WFD requires the Commission to propose a daughter directive on groundwater, which is expected to establish criteria for defining significant trends in pollutant concentrations, and addition criteria for defining good groundwater chemical status. The daughter directive will also clarify the meaning of the requirement to “prevent or limit the input of pollutants into groundwater” (1 above).

Objectives for protected areas.

In addition to those objectives in Table 2.3, it is required that objectives for protected areas established under Community legislation should also be met. For example, if a water body falls within a Nitrate Vulnerable Zone then the objectives of the Nitrates Directive (1991/676/EEC) must be met. In this instance, for groundwaters the

Nitrates Directive gives the criterion as < 50 mg/l NO_3, and for surface waters, the criteria are derived from the Drinking Water Directive (75/440/EEC), which gives the same mandatory upper limit value of 50 mg/l NO_3. Thus while the WFD introduces the new concept of good ecological status, it also incorporates the numerical limits of earlier legislation (Table 2.5).

Article 7of WFD requires Member States to establish drinking water protected areas for bodies of groundwater and surface water providing more than 10m^3 a day as an average or serving more than 50 persons, or bodies that are intended for that use in the future. The objective for these areas is to avoid deterioration in quality in order to reduce the level of purification treatment required.

Table 2.5 Existing community legislation designating protected areas.

Directive	**Reason for protection of waters**
2000/60/EC (Water Framework Directive)	Drinking water protected areas.
76/160/EEC (Bathing water Directive)	Bathing waters
78/659/EEC (Freshwater fish Directive)	Fresh waters needing protection in order to support fish life.
79/923/EEC (Shellfish waters Directive)	Shellfish waters
79/409/EEC (Birds Directive)	To protect birdlife
92/43/EEC (Habitats Directive)	Natural habitats of wild fauna and flora
91/271/EEC (Urban Waste Water Treatment Directive)	Nutrient sensitive areas
91/676/EEC (Nitrates Directive)	Prevent nitrate pollution

The first stage in undertaking this element of the assessment required by the WFD is straightforward since the only information required is whether or not the water body is in a protected area. If so, the required analysis will have been carried out and reported. If not, no action is required. Existing legislation that can define protected areas is listed in Table 2.5. It has already been noted that compiling a register of such protected areas is required by the WFD.

However, for some protected areas, notably those designated as Natura 2000 sites under the Habitats Directive, the requirement is to meet the water-related biological criteria of a particular habitat. This is clearly a more complex undertaking than comparing with threshold values, as illustrated above for the Nitrates Directive, but again existing reports under the terms of the Directives should provide a basis for the analysis required.

Recap of the objectives

The environmental conditions required to meet the objectives applicable to a water body depend on the water body type, and are derived from a number of sources. The objectives can be existing fixed numerical limits, or derived from the concept of "good status" that requires more explicit definition. For each particular pressure and impact analysis it will be necessary to have such numerical limits for general chemical elements (e.g. dissolved oxygen) although none is contained in the WFD. Such values will need to be determined through expert judgement within the competent authority. It is recommended that such judgement tries to anticipate the values that are likely to be adopted in the longer term.

2.3.7 Wetlands

Wetland ecosystems are ecologically and functionally part of the water environment, with potentially an important role to play in helping to achieve sustainable river basin management. The Water Framework Directive does not set environmental objectives for wetlands. However, wetlands that are dependent on groundwater bodies, form part of a surface water body, or are Protected Areas, will benefit from WFD obligations to protect and restore the status of water. Relevant definitions are developed in CIS horizontal Guidance Documents on water bodies (WFD Guidance Document No. 2) and further considered in Guidance on wetlands, currently under development.

Pressures on wetlands (for example physical modification or pollution) can result in impacts on the ecological status of water bodies. Measures to manage such pressures may therefore need to be considered as part of river basin management plans, where they are necessary to meet the environmental objectives of the Directive.

Wetland creation and enhancement can in appropriate circumstances offer sustainable, cost-effective and socially acceptable mechanisms for helping to achieve the environmental objectives of the Directive. In particular, wetlands can help to abate pollution impacts, contribute to mitigating the effects of droughts and floods, help to achieve sustainable coastal management and to promote groundwater recharge. The relevance of wetlands within programmes of measures is examined further in a separate horizontal Guidance on wetlands currently under development.

2.4 Summary of the process and actions required

Ideally, a pressures and impacts assessment will be a four-step process;

1. describing the "driving forces", especially land use, urban development, industry, agriculture and other activities which lead to pressures, without regard to their actual impacts;
2. identifying pressures with possible impacts on the water body and on water uses, by considering the magnitude of the pressures and the susceptibility of the water body;
3. assessing the impacts resulting from the pressure; and,
4. evaluating the likelihood of failing to meet the objective.

In the first instance (i.e. for 2004) the list of pressures and the assessment of impacts on a water body, and possibly on up- or downstream situated water bodies, shall ensure the identification of all of the potentially important problems. Assessing the likely impacts arising from each of the pressures will produce a list that can be used to identify points where monitoring is necessary to better understand if the water body is at risk of failing to achieve good status. This list then becomes a basis for developing a programme of measures which might be undertaken in order to achieve good status.

For the first stage, (i.e. for 2004) a screening approach is likely to simplify the tasks, as it means focusing on the search for pressures on those areas and pressure types that are likely to prevent meeting the objectives. However, this is a substantial task for the first review of the impact of human activities, and Member States should aim to achieve the best estimate of significant pressures in the time available. To improve confidence, the estimates of the type and magnitude of pressures should be crosschecked, where possible, with monitoring data and with information on the key drivers for the pressures. For example, estimates of point source inputs of organic matter from urban wastewater treatment systems made using information on discharges could be crosschecked with information on population sizes and average per capita inputs to assess whether the majority of relevant discharges have been identified.

The identification of significant pressures could involve a combined approach of assessing monitoring data, model usage and expert judgement. These pressures and furthermore those water bodies at risk of failing the environmental objectives shall be identified and reported. This reporting process must be practicable for Member States, but also demonstrate transparency of Member States' decision-making processes (e.g. in exercising its experts' judgement).

3. General approach for the analysis of pressures and impacts

3.1 Introduction

The preceding Chapters have described the scope and purpose of the WFD, and resolved issues relating to the general requirements to undertake a pressures and impacts analysis. The remainder of the Guidance provides advice on how this can be implemented. This Chapter explains the general approaches that can be taken according to water body type and data availability. In doing so it aims to show where the process and data requirements are common to the various water bodies within a river basin.

The key stages of the general approach as laid down in the WFD are:

- Identifying driving forces and pressures;
- Identifying the significant pressures;
- Assessing the impacts; and,
- Evaluating the likelihood of failing to meet the objectives.

These are addressed in the following Sections (3.2 to 3.6), and visualised in Figure 3.1. To undertake the four key stages, three supporting elements must be considered (shown on the left of Figure 3.1). The description of a water body and its catchment area will underpin the pressures and impacts analysis, and there are many types of information that may be useful, e.g. climate, geology, soil and land use. During the process, monitoring data relevant to the water body may also be introduced, and how this is used will be discussed in the Section on assessing the impacts (Section 3.4). A comparison of monitoring data with driving forces may also help to screen where pressures are likely to cause a failure in meeting objectives. It is also necessary to understand the objectives against which the actual state will be compared (see Section 2.3.6).

There will be many instances in which these key stages need not be undertaken as a linear sequence. An example of such a case would be where monitored data from the water body, which define an impact, can be used to refine the identification of significant pressures. While it may be appropriate to adopt a different sequence for the analysis, it is required that all key stages are addressed.

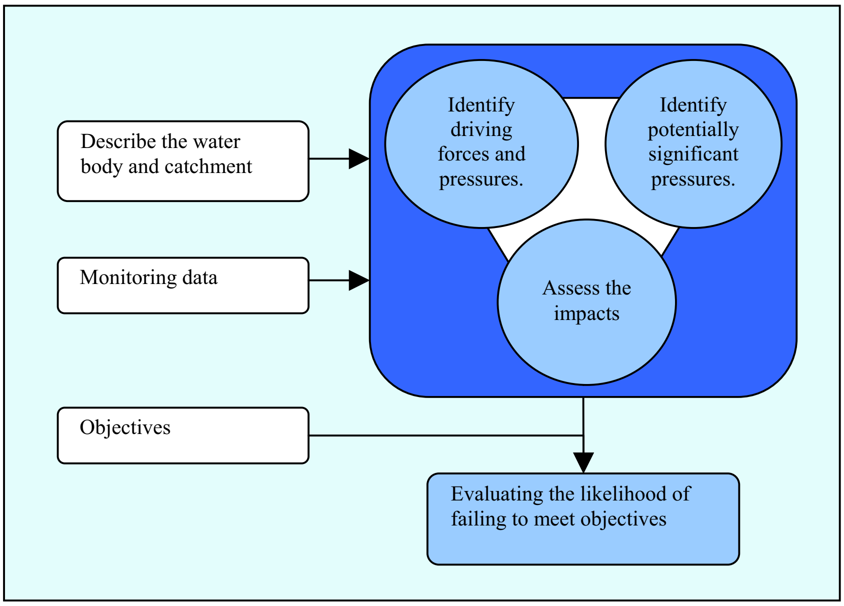


Figure 3.1 *Key components in the analysis of pressures and impacts. Those components on blue backgrounds on the right-hand side are the main components of the analysis, and are described in detail within this guidance, while those elements on white backgrounds on the left-hand side are supportive and are described only briefly within the guidance.*

In general this Guidance tries to apply similar considerations to surface and groundwaters. However, Section 3.9 considers issues that are particular to groundwaters, and Sections 3.11 and 3.12 provide reviews of the tasks required for the analysis for surface waters and groundwaters respectively. These may be regarded as checklists for the process with explanation, justification and rationale removed. Section 3.10 describes reporting requirements relating to the pressures and impacts analysis.

The subsequent Chapters provide more detailed information on tools (Chapter 4), data (Chapter 5), and illustrations based on case studies (Chapter 6).

3.1.1 Who needs to get involved in carrying out and using the pressures and impacts analysis

Assessing "who needs to get involved" requires addressing some of the following questions:

- Who can or will provide basic or additional input into the IMPRESS analysis?;
- Who will use the results of the pressures and impacts analysis?; and,
- Who will be influenced by the follow-up of the results of the IMPRESS analysis?

Answers to these "Who" questions are likely to include a wide range of organisations, stakeholders, and individuals which will vary according to questions. For example, experts from Ministry of Environment or other ministries (land planning, nature protection units, GIS units, agriculture, etc.), experts from river basin agencies or regional authorities, managers in charge of developing river basin management plans, ministry heads of water departments, researchers and consultants, historians, the public and a wide range of stakeholders that have interest and/or developed expertise in specific fields (see Tables in Chapter 5) and are involved in water management and will, presumably, be involved in the creation of the RBMP.

Developing a stakeholder analysis with possible involvement of key stakeholders can be an appropriate step for finding answers to these questions (see "public participation" WFD CIS Guidance Document No. 8 Annex I). It also helps in identifying key steps in the analytical process when involvement or input from specific stakeholders is required (different "Who" for different steps).

Points 3.2 and 3.3 of this Guidance give a more detailed inventory of the relationships between certain driving forces and pressures allowing stakeholders of interest to be identified.

3.2 Identifying driving forces and pressures

In addition to a general description of the water body, it is essential to identify the driving forces that may be exerting pressures on the water body. A broad categorisation of driving forces is shown in Table 3.1. This is expanded into a more complete list of driving forces and pressures in Chapter 4, which can be used as a checklist to form an inventory of the relevant pressures. In using this checklist it may be helpful to note all pressures without concern for their significance.

Table 3.1 Broad categorisation by driving force of pressures to be considered (Note that this is expanded into a complete list of pressures in Table 4.1).

DIFFUSE SOURCE	urban drainage (including runoff) agriculture diffuse forestry other diffuse
POINT SOURCE	waste water industry mining contaminated land agriculture point waste management aquaculture
ACTIVITIES USING SPECIFIC SUBSTANCES	manufacture, use and emissions from all industrial/agricultural sectors
ABSTRACTION	reduction in flow
ARTIFICIAL RECHARGE	groundwater recharge
MORPHOLOGICAL (Refer also to WFD CIS Guidance Document No 4 on HMWB)	flow regulation river management transitional and coastal management other morphological
OTHER ANTHROPOGENIC	miscellaneous

Driving forces (DF) are sectors of activities that may produce a series of pressures, either as point and non-point sources. As screening data, DF are quantified by aggregated data, simple to obtain, for example: number of hectares of arable land, population density, etc., for a certain area. Comparing this DF data with appropriate aggregated monitoring information quickly allows assessment of the likelihood that the considered DF is related to environmental pressures. In that case, only the expected pressures should be investigated in greater details.

The screening procedure is not only a way to speed up data collection by focusing on those pressures that are reasonably expected. It provides an independent assessment of pressures and impact relationships, which is valuable especially if emission and abstraction registers are poorly populated.

Information describing driving forces and pressures will be required for both surface water and groundwater bodies, as, for example agricultural activity may exert a pressure on both surface water and groundwater bodies. Similarly, an activity may exert a pressure on a number of downstream water bodies. For these reasons it is sensible to collate the data on the basis of river basins, or river basin districts, and then to abstract from this the particular information relevant to any individual water body. Clearly the use of a GIS will facilitate this process. However, this Guidance does not address the management of this information since this is the remit of the Geographical Information Systems Working Group within the CIS (see WFD CIS Guidance Document No 9).

3.3 Identifying significant pressures

3.3.1 Introduction

The inventory of pressures is likely to contain many that have no, or little, impact on the water body. In the case of surface waters, the WFD recognises this by only requiring significant pressures to be identified, and within this Guidance significant is interpreted as meaning that the pressure contributes to an impact that may result in the failing of an objective. For groundwaters, the initial characterisation requires a general analysis of pressures, corresponding to that described in Section 3.2, but again set in the context of evaluating the risk of failing to meet objectives. Thus, although the processes are described separately and differently for surface and groundwaters, a similar general approach to the identification of pressures that require further investigation can be adopted.

This requires an understanding of the nature of the impact that may result from a pressure, and appropriate methods to monitor or assess the relationship between impact and pressure. Possible impacts are considered below using the major pressure headings from Table 3.1.

Pollution pressures from diffuse and point sources

A pollution pressure results from an activity that may directly cause deterioration in the status of a water body. In most cases, such a pressure relates to the addition, or release, of substances into the environment. This can be the discharge of a waste product, but may also be the side-effect or by-product of some other activity, such as the leaching of nutrients from agricultural land. A pollution pressure may also be caused by an action such as a change in land use, for example sediment fluxes are modified by urbanisation, forestry, and a change between winter and spring planting of crops. The most usual categorisation of pollution pressures is to distinguish between diffuse and point sources (see Tables 3.2 and 3.3). However, the distinction between point and diffuse sources is not always clear, and may again relate to spatial scale. For example, areas of contaminated land might be considered as either diffuse or point sources of pollution.

In case of diffuse pollution driving forces are usually not directly related to pressures, but pollution reaches water bodies on hydrologically driven pathways.

Table 3.2 Examples of diffuse source pressures and their impacts.

Activity or Driving force	Pathway causing Pressure	Possible change in state or impact
Agriculture	Nutrient loss from agriculture by • surface runoff • soil erosion • artificial drainage flow • leaching (*i.e.* interflow, spring water and groundwater) (includes excess fertilisers and manures and mineralization of residues)	Nutrients modify ecosystem
	Pesticide loss by pathways mentioned above	Toxicity, contamination of potable water supplies
	Sediment loss by soil, bank and riverbed erosion	Smothering of bed, alteration of invertebrate assemblage, loss of spawning grounds
Industry discharges to the atmosphere	Deposition of compounds of nitrogen and sulphur.	Acidification of surface and groundwater bodies. Eutrophication
Transportation	Pollutant spillages	Gross pollution of water bodies
	Use of salt as de-icer	Elevated chloride concentration
	Use of herbicides	
	Engine exhausts	Increase in acidifying chemicals in atmosphere and hence deposition

Table 3.3 Example point source pressures and their impacts.

Activity or Driving force	Pressure	Possible change in state or impact
Industrial (IPPC and non-IPPC)	Effluent disposal to surface and groundwaters	Toxic substances have direct effect, increased suspended solids, organic matter alters oxygen regime, nutrients modify ecosystem
Urban activity	Effluent disposal to surface and groundwaters	As above
Landfill	Chemical fluxes in leachate	As above
Animal burial pits (e.g. following epidemic)	Contaminated leachate	As above
Former land use	Contaminated land	Various
Thermal power generation	Return of cooling waters cause alteration to thermal regime	Elevated temperatures, reduced dissolved oxygen, changes in biogeochemical process rates
	Biocides in cooling water	Direct toxic effect on aquatic fauna.
Dredging	Sediment disposal	Smothering of bed, alteration of invertebrate assemblage
	Removal of substrate	Loss of habitat
Fish farming	Feeding, medication, escaping	Nutrients, diseases, veterinary products, artificial fish population, modified food web

Quantitative resource pressures

Quantitative status is only referred to specifically within the WFD for groundwater bodies, but quantitative pressures must be assessed for all water bodies. For surface waters these pressures are used to assess hydromorphological status. In all water bodies quantitative pressures are also important as they have an effect on dilution, residence time, and storage. Examples of quantitative pressures are contained in Table 3.4.

Table 3.4 Example quantitative pressures and their impacts.

Activity or Driving force	Pressure	Possible change in state or impact
Agriculture and land use change	Modified water use by vegetation. Land sealing	Altered recharge of groundwater body
Abstraction for irrigation, public & private supply	Reduction in flow or aquifer storage	Reduced dilution of chemical fluxes. Reduced storage. Modified flow and ecological regimes. Saline intrusion. Modified dependent terrestrial ecosystem.
Artificial recharge	Increased storage	Increased outflow. Contamination of groundwater.
Water transfer	Increased flow in receiving water	Modified thermal, flow and ecological regimes

Hydromorphological pressures

Hydromorphological pressures can have a direct impact on surface waters in addition to the impact on quantitative status. Examples are contained in Table 3.5.

Table 3.5 Example hydromorphological pressures and their impacts.

Activity or Driving force	Pressure	Possible change in state or impact
Dredging	Sediment disposal	Smothering of bed, alteration of invertebrate assemblage
	Removal of substrate	Loss of habitat
	Change in water level	Change in water table, loss of wetlands, loss of spawning areas.
Physical barriers (dams, weirs etc.)	Variation in flow characteristics (e.g. volume, velocity, depth) both up and downstream of barrier.	Altered flow regime and habitat.
Channel modification (e.g. straightening)	Variation in flow characteristics (e.g. volume, velocity, depth)	Altered flow regime and habitat.

Biological pressures

Biological pressures are those that can have a direct impact on living resources, either quantitatively or qualitatively.

Table 3.6 Example biological pressures and their impacts.

Activity or Driving force	Pressure	Possible change in state or impact
Fisheries	Fishing	Reduced fish fauna, especially on migratory and amphibiotic fish
	Fish stocking	Genetic contamination of wild populations
Introduction of alien species	Competition with indigenous species	Substitution of populations, destruction of habitats, food competition

3.3.2 Methods

The assessment of whether a pressure on a water body is significant must be based on a knowledge of the pressures within the catchment area, together with some form of conceptual understanding, of water flow, chemical transfers, and biological functioning of the water body within the catchment system. In other words there must be some knowledge that a pressure may cause an impact because of the way the catchment system functions. This understanding coupled to the list of all pressures and the particular characteristics of the catchment makes it possible to identify the significant pressures. However this approach often requires two stages. In the first one, correlation assessment can be carried out. It has the advantage of using monitored data and doesn't require complex hypotheses. When necessary and appropriate, strict causality assessment may then be required using, for instance, numerical modelling, that will simulate the impact of numerous pressures. However these tools are seldom reliable, since they are based on hypotheses on the functioning of the ecosystem. Some likelihood assessment and models are considered in the Section on assessing impacts.

An alternative is that the conceptual understanding is embodied in a set of simple rules that indicate directly if a pressure is significant. One approach of this type is to compare the magnitude of the pressure with a criterion, or threshold, relevant to the water body type. Such an approach cannot be valid using one set of thresholds across Europe since this fails to recognise the particular characteristics of the water body and its vulnerability to the pressure. This approach effectively combines the pressure identification with the impact analysis since, if any threshold is exceeded, the water body is assessed as likely to fail its objectives. While simple, these methods can be an effective method of encapsulating expert judgement, and be based on sound science. These methods are described in more detail and with examples in Section 4.3. It can be more effective if coupled to state monitoring, as suggested in the examples.

A successful pressures and impacts study will not be one that follows prescriptive guidance. It will be a study in which there is a proper understanding of the objectives, a good description of the water body and its catchment area (including monitoring data), and a knowledge of how the catchment-system functions (Figure 3.2). One should be aware of the relations between water bodies within a river basin district, e.g. relations concerning pollution of downstream lakes and coastal waters (eutrophication, sediment pollution, bioaccumulation) or upstream river continuity issues. In such cases pressures only causing impacts far outside the water body itself should be included in the analysis as well.

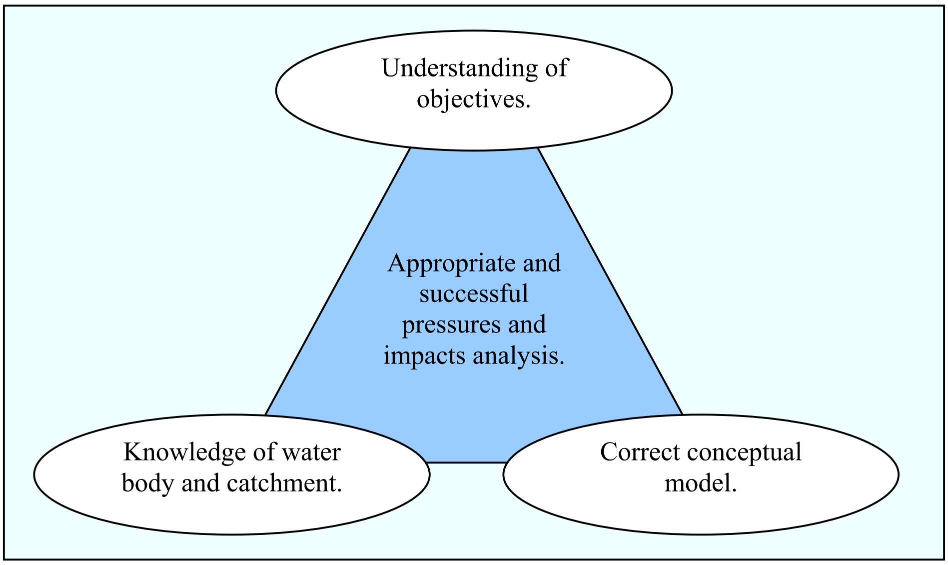


Figure 3.2 *The three prerequisites for an appropriate and successful pressures and impacts analysis.*

3.3.3 Variations in pressures and impacts

By definition the pressure of point sources cannot be spatially uniform, but it is probably also true that the pressures from diffuse sources, and quantitative pressures, are spatially variable within the catchment area of a water body.

As already mentioned, it is also the case that a specific pressure will not always cause a particular impact. Scale, both temporal and spatial, is one of the issues that that will determine the impact of a pressure. Other characteristics of the catchment area of the water body may also have an influence and of course the particular characteristic will relate to the nature of the pressure. For example, the impact of acid rain will be greater on the catchment located on granite geology with thin soils that have little acid neutralisation capacity, than on a catchment with calcareous (limestone or chalk) geology and soils with high acid neutralisation capacity. This effect is also recognised for other pressures, for example, the particular problems of nitrates within nitrate vulnerable zones, and the concept of groundwater vulnerability to pollution, which explores many characteristics associated with the groundwater body.

Recognising this variability leads to two conclusions. Firstly, it is easier to provide guidance on identifying all pressures (i.e. potential pressures) than on identifying significant pressures (i.e. those that may cause an impact likely to cause a failure of an objective). The latter will generally require a case-by-case assessment that considers the characteristics of the particular water body and its catchment area.

Secondly, in situations where the variability in the pressures and their impacts could result in different parts of a water body having different status, it may be appropriate to redefine the boundaries of the water bodies in order to develop a practical programme of measures for each one. Where this is done, redesignation must follow the ‘rules’ for water body delineation set out in Commission Guidance (d’Eugenio, 2002).

3.4 Assessing the impacts

Assessing the impacts on a water body requires some quantitative information to describe the state of the water body itself, and/or the pressures acting on it. The type of analysis will be dependent on what data are available. Regardless of the particular process to be adopted, and as with the identification of significant pressures described above, the assessment requires a conceptual understanding of what causes impacts. For example, at its simplest this can be, that if effluent is discharged to a river, lake, or coastal water, there is likely to be at least a local change in the water quality, which might be adequately estimated by a conservative mixing model. In many situations a simple approach of this type may be completely suitable for assessing the impact of a pressure. However, in real situations there will be a vast range of catchment types, water body types, interacting pressures, process conceptualisations, data requirements and possible impacts, and adopting such a simple model in all cases may be naïve.

It is also the case that what initially appears a simple assessment can have hidden complexities. For example, the impact on the quantitative status of a groundwater body from the pressure of an abstraction might be investigated by a simple water balance model in which the change in storage is the difference between the recharge rate and the sum of the outflow plus abstraction. One criterion for good quantitative status is that both the outflow and the abstraction can be sustained in the long term. The level at which the outflow must be maintained is such that good ecological status is achieved in any associated surface waters. Thus, what appears to be a simple water balance of a groundwater body actually requires knowledge and understanding of the ecological status and ecological flow requirements of an associated surface water body.

For the pressures and impacts analysis the conclusion cannot be that this analysis can only be achieved by constructing a detailed, process-based, numerical computer model of the entire linked surface and groundwater system. This type of approach may be possible, in some situations and examples are described in the Chapter on tools (Section 4). In practice, the information required to adopt the modelling approach will rarely be available at present, and probably not generally in the foreseeable future. By implication, the initial analysis will usually be based on less demanding methods for which the required data are available, e.g. pressure screening tools (see Section 4.2 and 4.3). Such analyses will be subject to refinement as further analysis is needed to determine risk, relevant data become available, and useable tools are developed.

Using observed data to assess impacts

In situations where data are available for the water body itself, it may be possible to make a direct assessment of the impact. The types of data that might be used are as diverse as the impacts themselves (see Table 3.7).

Data itself is not enough to assess a possible impact: a correct indicator of the expected impact must be constructed. Moreover, it must be kept in mind that most pressures do not create a clear-cut impact, but substantially change the probability of adverse conditions. This is, for example, the case of hydrological regime perturbations: the natural hydrological regime is not favourable to fish life 100% of the time. The impact assessment requires an estimate of which change in the probability of occurrence of favourable circumstances represents a threat to the ecosystem. Commonly available hydrologic indicators are not helpful. For example, a fish ladder is efficient if the discharge is between certain limits, during certain times and at a precise moment of the year, when migratory fish are present. This requires specific calculation, based on daily discharge statistics and expert opinion (i.e. which discharge values at what time).

Water quality statistics present specific difficulties as well. Comparison in state (i.e. is there an impact?) requires comparison between series of data. To carry out a meaningful comparison, the internal structure of the data must be considered in order to allow for normal variability. Removing the seasonal and the hydrologic component of annual data dramatically reduces the calculated variance and allows comparison to be made between data sets monitored at short time intervals. These sophisticated statistical techniques may not be familiar to European water experts.

Table 3.7 Possible impacts or changes in state that can be identified from monitoring data.

BIOLOGICAL QUALITY ELEMENTS	
macrophytes	composition abundance
phytoplankton	composition abundance biomass
planktonic blooms	frequency intensity
benthic invertebrates	composition abundance
fish	composition abundance age structure
eutrophication	chlorophyll concentration
HYDROMORPHOLOGICAL QUALITY ELEMENTS	
hydrological regime	quantity and dynamics of water flow connection to groundwater bodies residence time
tidal regime	freshwater flow direction of dominant currents wave exposure
river continuity	
morphology	depth and width variation quantity, structure and substrate of the bed structure of the riparian zone, lake shore or intertidal zone
CHEMICAL AND PHYSICO-CHEMICAL QUALITY ELEMENTS	
transparency	concentration of total suspended solids turbidity Secchi disc transparency (m)
thermal conditions	temperature (°C)
oxygenation conditions	concentration
conductivity	conductance converted to concentration of total dissolved solids
salinity	concentration
nutrient status	concentration of nitrogen and phosphorus, loads in view of sea protection

CHEMICAL AND PHYSICO-CHEMICAL QUALITY ELEMENTS cont'd	
acidification status	pH alkalinity acid neutralising capacity (ANC)
priority substances	concentration
other pollutants	concentration

Modelling approaches

Modelling approaches allow impacts to be estimated, and should therefore be considered subordinate, or complementary, to monitored data from the water body. For the river network itself numerous modelling techniques have been developed from the original work on dissolved oxygen and BOD published in 1925 by Streeter and Phelps. Simple models of this type are widely available but differ in the range of chemical determinands modelled, the processes represented, and their numerical frameworks. Such models, if applied appropriately, are generally good at representing the water quality along a river in which the inflows from tributaries and point sources are well known or can be estimated reliably. An example application is contained in the Chapter on tools.

A limitation of such river models is that they represent diffuse source inputs as discrete point sources, and to run the model these must be defined, either using data or a diffuse (catchment) model. The diffuse model itself can be simple, for example nutrient loss can be based on export coefficients that represent the activity within the catchment area. Such a model is in fact quantifying the pressures that arise from diffuse sources, rather than the impact on a water body, and is described in this sense in the Chapter on tools (Section 4). This Section also describes tools that can estimate the point source loads to receiving water bodies.

Simple and reliable modelling approaches are available for all of the water body types recognised by the WFD. These models can represent a single domain (i.e. river, lake, transitional water, coastal water, or groundwater), or encompass many, or all, domains within a single framework. These models can represent various aspects of the flow regime, hydromorphology, and hydrochemistry of the water body, either separately or within an integrated framework. Examples of water body models are contained in Section 4.4.

Of course the complexity of all of these different domain models can be increased greatly from the relatively simple implementations described above. However, it is certainly not the case that a simple model will always be less accurate than a complex model.

Models also exist to characterize stream habitat, and many of them can be used to predict habitat conditions at various flow conditions. The expected output of this type of model can vary from being purely descriptive of the stream physical template, to having some biological assessment applications. Physical descriptive models are developed to evaluate the degree of alteration of a given stream channel in relation to some reference conditions. Biologically-based models are developed to infer the standing stock of a given species from the physical characteristics of a given stream. Nevertheless, in between these two extremes there exists a range of habitat models addressed to obtain other outputs as habitat usage of species, habitat quality (e.g. ecological potential for key species) or duration period of habitat suitability.

Using observed data to refine the assessment of impacts and pressures

Monitoring data may indicate that there are no current impacts. This information itself reveals that none of the pressures identified in the initial screening process is significant, or that the time lag required for a pressure to give rise to an impact has not yet passed. The latter is likely to be of particular importance when assessing groundwater bodies in which pollutants travel very slowly. Such data could also be used within a model as a check that the inputs to, and processes within, the model correctly reproduce the observed data.

When the observed data for a water body does not indicate that a pressure is causing an impact, there may be a causal relationship with an impact on other water bodies within the same river basin district. For example, just meeting the environmental objectives in upstream areas will not leave sufficient room for compliance with the same objectives in downstream areas. This requires communication and co-operation between several parts of the river basin district.

In situations where observed data shows there is an impact, knowledge of the nature of the impact should be helpful in undertaking the pressures and impacts analysis. There are three cases to consider:

1. The traditional situation in which the impact is quantified in terms of a chemical, or physico-chemical, parameter exceeding a threshold. This should be relatively straightforward to address using a simple conceptual model of known activities, and associated pressures. The analysis is rather similar to the approaches described above except that the result is known and essentially serves to validate the various assumptions that have been made in the process;
2. The impact is quantified in terms of a biological effect, but the physico-chemical or hydromorphological pressure that is causing it is not understood. In this case the pressures and impacts analysis can be undertaken in the expectation that the cause will be identified, and can be addressed even though the link is not fully understood. This would probably be accompanied by further biological investigation into probable causes; and,
3. Between these two cases would be a biological effect where the probable physico-chemical or hydromorphological effect is at least partly understood. In this instance the analysis might proceed as in 1, but with less robust information to inform the validity of the process.

Understanding the last two of these situations depends greatly on the information to come from the REFCOND working group and the CIS Intercalibration Study (refer WFD CIS Guidance Document No.s 10 and 6, respectively).

In all three of these situations it is perhaps easier to understand how a pollution pressure causes a change in physico-chemical state which may cause an impact on biological status, and consider the links both forwards from pressure to impact, and backwards from impact to pressure. For hydromorphological pressures the links are less clear. The HMWB Guidance offers some assistance in relating biological indicators to different types of hydromorphological pressure (Table 3.8).

Table 3.8 Biological indicators of morphological pressures (adapted from WFD CIS Guidance Document No 4 on HMWB).

Indicator	Pressure
Benthic invertebrate fauna and fish	Hydropower generation impacts in freshwater systems
Long distance migrating fish species	Disruption in river continuity inducing lag in migratory process
Macrophytes	Flow from reservoirs Regulated lakes (change in flow regime)
Benthic invertebrates and macrophytes/phytobenthos	Linear physical alterations, such as flood works.

3.5 Selecting relevant pollutants on river basin level

3.5.1 Introduction

In Section 2.3.6 of this guidance, an introduction was given as regards the rather complex approach for dealing with chemical pollutants within the concept of the "good ecological status" and "good chemical status" of the WFD. Whereas the "priority substances" are clearly identified in Annex X, one key question in the context of the analysis of pressures and impacts is the selection of **specific pollutants** (other than priority substances) for which data on pressures must be collected in order to assess whether there are impacts for the different water bodies in a river basin (district).

The subsequent paragraphs provide a generic approach that may be used for the selection of a list of relevant specific pollutants for water bodies within a river basin (hereafter referred to as "relevant pollutants"). More specific examples are provided in Annex IV of this guidance. It is evident, that such an approach may need to be adapted and refined for the specific situation in each river basin.

At this point, it should be clarified that the requirements of the WFD are related to several objectives for individual pollutants in a water body. However, it will be necessary to follow a three (or more) stage approach in order take account of the different scales of pollution problems in the aquatic environment:

1. **European level**: the "priority substances" (Annex X) represent a list of European relevance. These substances must be considered in the pressure and impact analysis and the "risk of failing the objectives" must be investigated for all water bodies;
2. **River basin (district) level**: a list of those relevant pollutants may be established which are likely to have a "risk of failing the objectives" in a large number of water bodies within that basin and where downstream effects (including the marine environment) may need to be considered. Such substances may be called "relevant pollutants for a river basin";
3. **Sub-river basin and water body level**: pollutants which cause an impact through a significant regional and local pressure, i.e. in one or few water bodies, may need to be considered in addition to the above-mentioned levels.

Hence, the issue on how to select a list of relevant pollutants is related to significant pressures or impacts. In the ideal case, there may be a clear relationship between a pollutant released to the environment at a number of well-known sources and causing a visible or measurable effect on the biology of a water body. This supposes at least a good knowledge of the uses or the sources of the pollutant on the pressure side, the occurrence of the pollutant on the status side and/or the effects on the impact side. However, given the high number of pollutants, there is a considerable gap of information and data for many pollutants, in particular:

- In many cases and for a lot of pollutants, pressures cannot be related to status or impact due to lack of data;
- Only a limited number of pollutants are continuously or regularly monitored;
- The relation between pollutants and impact covers the whole field of ecotoxicology; for example should acute/chronic or combined effects be reported?

Nevertheless, the analysis of pressures and impacts is the first important step towards the identification of those pollutants which are being regulated further in the context of the WFD, i.e., *inter alia*, monitoring and programme of measures.

The starting point in the WFD is the list of 'main pollutants' mentioned in annex VIII. This list can be considered equivalent to the "universe of chemicals", hence no chemical substance or pollutant can be excluded from the beginning.

The challenge is to develop an iterative approach which narrows the endless list of substances down to a manageable number of pollutants in a pragmatic and targeted step-by-step way ("from coarse to fine"). The final aim is to target the measures and the monitoring to those substances first which most affect the aquatic environment on the different levels mentioned above. In that respect, the "environmental quality standard" (EQS) set in accordance to Annex V, 1.2.6 is the most important benchmark since it represents the boundary between "good" and "moderate" status. However, there are a number of other objectives which have to be assessed in the context of the pressure and impact analysis such as the "no deterioration", the reduction of pollution as regards the trend and the avoidance of failing good status downstream.

The list of relevant pollutants may change during the different steps in the implementation of the WFD mainly due to a refinement of the analysis and assessments.

First, a list of pollutants needs to be established for which the pressure and impact analysis is carried out (completed by 2004). Only if a defined "list of candidate substances" is established, it is possible to collect data on significant pressures and impacts. For this first analysis, it may not be possible to derive EQSs for all candidate substances. In this case, alternative screening benchmarks are acceptable.

Second, the selection of those pollutants is required for which additional information is gathered through "surveillance monitoring" (by 2006). These substances may be a sub-list of pollutants for which the level of certainty in the pressure and impact analysis may not be sufficient.

Finally, the list of relevant pollutants must be identified for which measures are prepared (by 2007/2008).

During this process, it is important that the evolution of the relevant pollutants remains transparent and clearly linked to the objectives and the requirements of the WFD.

As a final remark, it should be mentioned that the WFD Annex V states that priority and other substances should be identified which are "discharged" into the water body. Unfortunately, the term discharge is not defined in the WFD but only under the Dangerous Substances Directive (Council Directive 76/464/EEC) as, in general terms, the "introduction into waters". In contrast, the term "discharge" is often used for point sources from effluents. Given that Annex II clearly requires the identification of all (significant) pressures from point and diffuse sources and given that the WFD mostly talks about "discharges, emissions and losses", it is evident that a broad interpretation which covers all sources and pathways into the aquatic environment must be considered throughout the WFD.

3.5.2 Generic Approach

The generic approach is detailed in Table 3.9 and illustrated in Figure 3.3. Note that these steps are presented in a linear, way but in fact interact which each other in a more complex way (as implied by the arrows in Figure 3.3).

Table 3.9 The generic approach to the identification of specific pollutants.

1. Starting point
The indicative list of the main pollutants set out in Annex VIII of the Directive. Only those pollutants under points 1 to 9 need further consideration as potential specific pollutants. The pollutants under points 10, 11 and 12 of the Annex are the general physico-chemical quality elements and are considered separately.
2. Screening
A screening of all available information on pollution sources, impacts of pollutants and production and usage of pollutants in order to identify those pollutants that are being discharged into water bodies in the river basin district. In the screening step, two sub-steps can be distinguished: a) collation of information, and b) deriving a list of pollutants.
2a. Collation of information
Data: ➢ Source/sectoral analyses: production processes, usage, treatment, emissions,; ➢ Impacts: change of the occurrence of pollutants in the water body (water quality monitoring data, special surveys; ➢ Pollutants: intrinsic properties of the pollutants affecting their likely pathways into the water environment. Information from existing obligations and programmes: ➢ Priority substances; ➢ 76/464; ➢ UNEP POPs list; ➢ EPER; ➢ COMPPS; ➢ Results of 793/93, users lists, etc.
2b. Deriving a list of pollutants
Assessment of information collated under Step 2a will result in a working list of those pollutants identified as being discharged into water bodies. Most of these pollutants will be selected by the combination of a top-down and bottom-up approach (see further Chapter 6, WRc-example on 'Selection of relevant pollutants (river-basin substances) experiences from Council Directive 76/464). Pollutants for which there is adequate confidence that they are not being discharged into water bodies may be excluded from further consideration.
3. Test for relevance

Step 2 deals only with the identification of pollutants being discharged into water bodies. Step 3 selects from these those pollutants that are likely to cause, or to already be causing, harm to the environment. This will depend on the intrinsic properties of the pollutants, their fate and behaviour in the environment and the magnitude of their discharges. Selection should ideally be based on an assessment of the environmental significance of the concentrations (and trends in concentrations) estimated for the pollutants or their breakdown products in the water bodies. However, effects data or an assessment of the significance of predicted loads may also be relevant in the selection process. Two sub-steps are envisaged in the test for relevance a) estimating concentrations in water bodies; and b) comparing the estimated concentrations with suitable ‘benchmarks’.
3a. Obtaining data on concentrations in, and loads to surface water bodies
By monitoring: i.e. measured data; By modelling: i.e. estimated data (obtained by models varying from simple calculations to complex models as mentioned in Chapter 4. Tools).
3b. Comparing concentrations with benchmarks
Pollutants identified under Step 2 may be excluded where their concentrations are estimated to be lower than the most relevant critical value such as estimated LC50, NOEC, PNEC, EQS or critical load. EQSs: are supposed to reflect the good status condition of a water body. They must be derived from ecotoxicological data. Exceeding EQS-values would be considered harmful to the environment. Where possible, monitored or estimated concentrations should be compared with the appropriate EQS; Critical loads: identified for some reduction programmes (e.g. North Sea Conference) require load reduction for some pollutants. Only critical (i.e. environmentally significant) loads need be considered in identifying the specific pollutants. Remarks: Existing EQSs do not always reflect the actual effects concentrations. In addition, EQSs have not been derived for all potential specific pollutants. The best estimate for the EQS should be used based on the most recent ecotoxicological data. Effects data from monitoring programmes should be taken into account where available. Natural background concentrations may exceed EQSs for non-synthetic pollutants. Potential accumulations in sediment or biota should be considered. Detection limits must be disregarded, as they have no discriminating basis in the context of environmental significance.
4. Safety net
A safety net is needed to ensure that pollutants that may be environmentally significant are not incorrectly excluded from the list of specific pollutants during Step 3 above. For example, the safety net should consider: ➢ Whether a number of small (individually minor) pollution sources may be expected to have a significant combined effect; ➢ Trends that may indicate an increasing importance of a pollutant, even though the EQS is not currently exceeded; ➢ The presence of pollutants with similar modes of toxic action and hence potentially additive effects. For some pollutants the assessments made in Steps 2 and 3 may not provide adequate confidence that a pollutant is either not being discharged or not presenting a significant environmental risk. For example, confidence may be low if the tests for environmental significance under Step 3 are based on EQSs that were derived using insufficient or inadequate ecotoxicological data. In such cases, the uncertainty should be taken into account in deciding whether to identify the pollutant as a specific pollutant, and appropriate further investigations should be made to improve confidence in the selection procedure.
5 Final outcome
The final outcome must be a list of specific pollutants relevant to a river basin district or to particular water bodies within a river basin district.

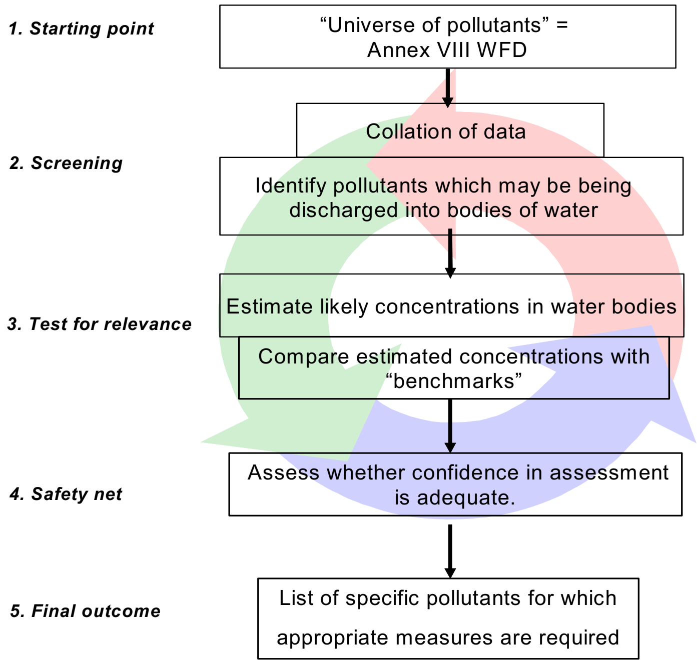


Figure 3.3 Steps needed to derive a selected list of pollutants

3.6 Evaluating the risk of failing the objectives

In theory, evaluating the risk of failing objectives should be a straightforward comparison of the state of the water body with threshold values that define the objective. This Guidance has proposed some general approaches to the estimation of the state of the water body, and most notably to elements relating to chemical and physical attributes. At present the threshold values are known for those elements of status that relate to protected areas and dangerous substances (Council Directive 76/464/EEC). For other aspects of status these values are not yet known e.g. the threshold values that define good chemical status.

In the period prior to the definition of these thresholds it will be necessary to use some interim thresholds defined by expert judgement, and applicable within eco-regions or smaller geographical units. For surface waters, and ground waters where the ecological status of an associated surface water body must be considered, a particular issue is to bridge the gap in understanding between biological status and physico-chemical conditions. This has been partially addressed by classification systems that exist within member states but at present they must be taken as indicative of conditions which could correspond to any particular biological status. While these classification systems differ in their detail, the classes are often labelled according to an overall assessment of status. For example, the best class may be *natural, background* or *excellent*. Below this there is usually a differentiation between a class that is slightly impacted, but has generally acceptable status (perhaps labelled *good*), and a class with greater impact that is seen as unacceptable (labelled *fair* or *moderate*). This distinction between good and moderate in the existing scheme could be used in the analysis prior to 2004 to separate bodies not at risk from those that are risk of failing WFD objectives.

It should be noted that such classification schemes generally only contain physico-chemical elements and therefore do not directly include morphological pressures. Thus while such a scheme might correctly reflect the state of the water body, it might hide the cause, e.g. a change in water chemistry could be caused by a change in flow regime.

To be usable these national schemes should meet one or more of the following requirements, which are related to the objectives of the WFD.

- The state data used for classification should
  for surface water (ecological status):
    - be closely related to the biological elements described in WFD Annex V;
    - be a relevant pollutant on river basin level;
  for surface water (chemical status):
    - be substances of WFD Annex X ;
  for groundwater:
    - describe the status (chemical and quantitative);
- The classification should have classes for
  - the background/natural state for surface waters;
  - a targeted state (e.g. "good status") below which the water body would be "at risk";
  - below classes which fail the target.
- The used quality objectives should be taken from EU-legislation and/or estimated Environmental Quality Standards in accordance with the procedure set out in WFD Annex V.

Examples of these schemes for impact assessment are presented in Annex IV, 4.

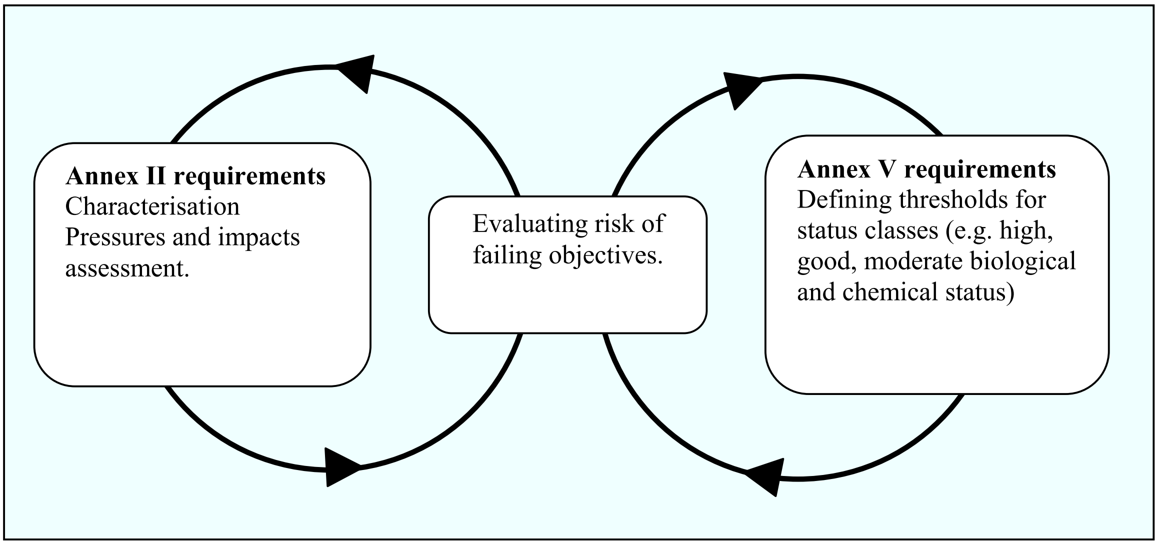


Figure 3.4 The iterative evaluation of the risk of failing objectives

For groundwater bodies, the use of monitoring data for evaluating the risk of failing to achieve good chemical status needs careful consideration, having regard to the specific environmental objective(s) that could lead to a failure to achieve good status.

It is clear that the process of evaluating the risk of failure is to some degree an iterative collaboration between those undertaking the pressures and impact analysis, and those defining thresholds for the as yet undefined elements of status (Figure 3.4).

3.7 Conceptual model approach

(Note: Model is used in this Chapter as a synonym for "understanding" and does not usually mean "numerical model"!).

A conceptual understanding of the flow system, chemical and, in the case of surface water, also the ecological variations within a water body and the interaction between groundwater and surface ecosystems is essential for characterisation.

A significant strength of the approach is that it allows a wide variety of data types (including, for example physical, biological and chemical data) to be integrated into a coherent understanding of the system. As new data are obtained they help to refine, or change, the model; conversely the model may indicate errors and inadequacies in the data.

A conceptual model is dynamic, evolving with time as new data are obtained and as the model is tested. Its development and refinement should adopt an iterative approach. The approach therefore fits in well with the various levels of knowledge required at different stages of the WFD. For example a basic model will be appropriate for initial characterisation; this (if appropriate) will be refined and improved during further characterisation, and again during the review cycle of the RBMP.

The construction of basic conceptual models of groundwater flow and chemical systems, and then of groundwater bodies must be undertaken early in the process of initial groundwater characterisation. This will include the delineation of the groundwater body boundaries and an initial understanding of the nature of the flow and geochemical system and interaction with surface water bodies and terrestrial ecosystems. It will also involve water quality information and an early assessment of pressures. In essence the model should describe the nature of the aquifer system, both in terms of quantity and quality, and the likely consequences of pressures. It is vital, even at the stage of groundwater body delineation that a coherent understanding of the body is reached. All data concerning the nature of the groundwater body collected during the characterisation process should be tested against the conceptual model, both to refine the model and to check for data errors.

3.8 Use of analogous water bodies

In situations with no observed data, one possible means to evaluate status is to use a similar *analogous* site for which data are available, and to assume that the assessment made from the observed data can be applied validly to both sites. To be most useful in the concept of the WFD pressures and impacts analysis the site for which data are available must have good status, since a failure may require more detailed study. The possibility of grouping water bodies for the purpose of pressure and impact analysis and monitoring is addressed in the *Horizontal Guidance on "Water Bodies"* (WFD Guidance Document No. 2), for example, bodies subject to similar pressures and with similar characteristics could be grouped.

A key concern in considering whether a site with data can be taken as analogous to the study site is the importance of proximity. Proximity in itself often indicates that many features of the two catchments will be similar (e.g. ecology, topography, geology, climate, channel characteristics and land use). However, since these characteristics can also change abruptly, proximity cannot be taken on its own as an indication of similarity. Indeed, it can be the case that a more distant catchment in fact provides a better analogy than a neighbouring catchment.

The assessment of similarity is probably best made on the basis of transparent and accountable expert judgement of the general characteristics. However, it is possible to formalise this process by having a numerical evaluation of each characteristic and combining these to give some form of objective measure of similarity. Such a scheme would require some local weighting of the characteristics included, and would therefore need to be developed regionally within Europe.

Major point source discharges, or other anthropogenic modifications that take effect at a particular location (e.g. abstraction, or impoundment) in either the study, or potential analogue catchment, will almost certainly mean that this approach cannot be used, since the particular characteristics of the point source impact will be highly dependent on the location within the catchment.

3.9 Specific considerations for the characterisation of groundwater bodies

The pressures on a groundwater body may have an impact, or measurable effect, upon it. The nature of the impact will depend on factors such as the type and severity of the pressure and the degree to which the groundwater body is susceptible to the pressure. Additionally, the geographical scale (e.g. distribution and density of pressures) and timescale effects (e.g. time lag for pollutants released at the land surface to reach the water table or migrate within an aquifer) are important considerations in assessing the risks to the groundwater body as a whole, and over time. The result of a pressure causing an impact may often be manifested in monitoring data after a considerable delay. For example, pesticide application to a wide area of land surface over a groundwater body may lead to increased concentrations of the pesticide in the groundwater many years after it was released. Monitoring information should be used, where available, to validate estimates of impacts obtained from pressure analyses.

Assessing impacts of pressures

Once the likely activities handling pollutants, abstracting from, or discharging to groundwater have been identified, the problem remains of translating this information into a measure of "pressure". There are two main issues to be addressed:

- For a given activity potentially producing a pollutant, how can the intensity and distribution of the activity be translated into a pressure?; and;
- How can the pressures assessed from different activities be combined to produce a measure of total pressure on the groundwater body?

Assessing the impact of pressures on groundwater bodies - initial characterisation

It is suggested that the concept of "potential impact" is introduced to describe the effects that a pressure is likely to have on a groundwater body, and that potential impact is used in the evaluation of whether the body is "at risk" of failing the Article 4 objectives. This concept recognises that, with the constraints on the characterisation process, it will not always be possible to accurately measure the impact by monitoring groundwater levels and quality. For pollution pressures the potential impact is judged by considering the pollution pressure (where this occurs at the ground surface) in combination with a measure of the vulnerability of the groundwater body to pollution (Figure 3.6). Thus, for example, a high pollution pressure caused by anthropogenic activities at the ground surface above an aquifer ***may*** have little impact on a groundwater body within the aquifer ***if*** that body is protected by a significant thickness of low permeability overburden. For quantitative pressures, such as abstraction, the potential impact of the pressure on the body is likely to involve reductions in water level and reduced outflows. These may be estimated using the conceptual model of the flow system, and undertaking a water balance for the groundwater body.

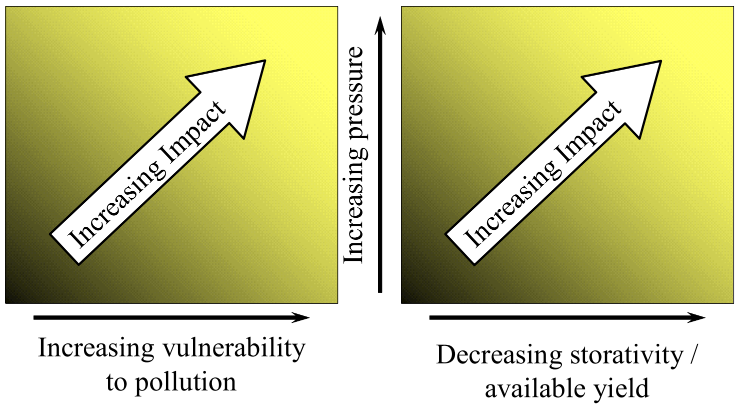


Figure 3.6 Impact is a consequence of both the magnitude of the pollution or abstraction pressure and the susceptibility of the groundwater to that pressure.

The assessment will typically be made following refinement of the conceptual model. Using that conceptual model, a decision must be made as to whether it is likely that the groundwater body is likely to fail to achieve good chemical status and, separately, good quantitative status. The overall assessment of whether the groundwater body is 'at risk' adopts the poorer predicted status, where they differ.

Assessments of the potential impacts resulting from pressures should be validated in areas where monitoring data are available. The data should also be used to ascertain any trends in water chemistry.

Assessing the impact of pressures on groundwater bodies - further characterisation

A "review of the impact of human activity" for 'at risk' groundwater bodies and those crossing Member State boundaries is explicitly required by WFD Annex II, Section 2.3.

The approach recommended follows that outlined for initial characterisation, but requires the collection of more detailed information and data, such as that detailed in Annex II, 2.3.

The wording of Annex II suggests that the information specified shall be included "where relevant". In this context "relevant" is taken to mean relevant to the assessment of risk of failure to meet Article 4 objectives. It does not give licence to avoid collecting information. The concept of "relevance" also involves questions of the level of detail that should be sought and, for human activities, the timescale over which the effects of the activity may be deemed relevant. In deciding these matters it is important to refer back to the purpose of further characterisation - to improve the assessment of risk and identify any measures to be required under Article 11. Thus, if the collection of more detailed information of a particular type is likely to improve the conceptual model sufficiently to enable the risk assessment to be enhanced, and if the extra detail can be obtained then the data should be collected.

3.10 Recommendations on reporting on the pressure and impact analysis

Article 15 (2) requires Member States to submit a summary report of the pressures and impact analyses to the Commission within three months of their completion (i.e. the first report must be submitted by March 2005).

This Section provides initial recommendations on the content and presentation of the summary report, in order to support consistency and comparability of results across the Community. All recommendations will be discussed within the EAF Reporting, which will provide the final Guidance on all reporting commitments.

The summary report has several aims:

- It fulfills Directive's reporting obligations with regard to the pressures and impacts analyses by Member States;
- If a common format is used this will provide a comparable basis for harmonization of water management on a river basin scale between countries within international RBDs;
- Provides a transparent overview of the analysis & results to communicate with government, stakeholders and the public.

The summary report sent to the Commission should be concise and give an overview of water bodies, their current state and the specific conditions of the RBD. The summary report will be complemented by reporting obligations within the respective RBDs. Suggested elements of the reporting required for 2005 are contained in Table 3.9.

Table 3.9 Elements of reporting according to Article 15 "Review of the impact of human activity on the status of surface waters and on groundwater"

- Short summary of relevant characteristics of the RBD (map of river basin district, protected areas, main water bodies, land use map);
- Summary of methods used (tools, thresholds, classifications) and assumptions made within the analyses;
- Cross reference to the other reporting obligations (article 5).

Pressures and Impacts report:
It is recommended that the following is produced as a report:

- Overall map of water bodies which are assessed to be at risk of failing their environmental objectives;
- Summary map for each general pressure type identified in Annex II identifying where (in which water bodies) that pressure type is identified as one of the main causes of the risk of failing to achieve the environmental objectives (i.e. for which the pressure is a significant pressure);
- The summary map should also include an indication of the variation in the level of uncertainty achieved in the pressure analysis;
- These maps may be presented in GIS format. This will be discussed with the GIS working group.

As an alternative the following could be produced:

- Overall map of water bodies which are assessed to be at risk of failing their environmental objectives;
- Supplementary table showing the main sources of pressures (e.g. substances);
- Summary table on number or area /percentage of water bodies which are at risk of failing their environmental objectives;
- Summary of major issues/pressures in the river basin district.

Regardless of the reporting format, the summary report should also include information on:

- applied methods, tools, thresholds, environmental quality objectives, classification schemes etc. used within the analyses;
- the amount of (un)certainty of analysis and results. The detailed RBD report may contain further information on the relative contribution of monitoring data, models and expert judgement within each analysis.

Further, more detailed information should be available on demand for public and stakeholder consultation. It is expected that this information may include:

- An overview of the available data on actual status of water bodies (chemical, ecological status) related to environmental objectives (a list of water bodies which are presently failing their environmental objectives);
- A list of the significant pressures in the district, subdivided according to Annex II, 1.4;
- A description of impacts and their connection to pressures;
- Delineation of the results of the pressure and impact analysis with maps:
    - overview map with river basin districts, locality and boundaries of water bodies;
    - maps of significant pressures in the river basin district;
    - maps of water bodies which are assessed to be at risk of failing the objectives in 2015.

The way this information is stored and made available will of course depend on nationally used data and reporting facilities.

Further reporting requirements may arise from the process of developing the RBMPs according to Article 13, WFD.

3.11 Review for surface water

For surface waters the WFD contains many specific requirements for the pressures and impacts analysis, while certain other aspects require interpretation and guidance. Thus while some particular substances and activities are identified, it is left open as to what constitutes a *significant* pressure. By taking this to mean any pressure that may contribute to the failure to achieve an objective, it is clear that understanding the objectives that are applicable to a water body is the foundation for the pressures and impacts analysis. Since at the outset of the analysis it is not known if an activity can contribute to such a failure, some knowledge is required of all activities within the catchment area. The analysis will then help to identify those that are significant, and must be based on some form of conceptual understanding, or model, of how the activity creates a pressure which causes an impact. The DPSIR framework provides a useful structure for this process.

The nature of the conceptual understanding coupled with knowledge of the water body's characteristics, will determine the type of pressures and impacts analysis that can be done. In practice a range of analyses will be used ranging from the simple to the complex. In some instances the simple methods may provide the only available option, but they may also be used as screening tools to decide whether more complex methods are necessary, or as the first stage in a recursive process.

These major elements can be broken down into list of key tasks and this is presented as a summary checklist as in the text box opposite.

Summary of key tasks for surface water

Data collation for river basin (prerequisite to the pressures and impacts analysis)::

- Access or establish database and data management systems on activities within the river basin district, and existing monitoring data.

Basic information specific to water body:

- Abstract information on driving forces in the catchment area of the water body;
- Identify pressures caused by the driving forces taking particular regard to those pressures listed under Annex II 1.4;
- Abstract data specific to the water body, including quantitative, hydromorphological, physical, chemical and biological data;
- Identify dependent water bodies and water bodies on which the water body under consideration is dependent as well as their basins;
- If relevant, ensure links with data managers of upstream and downstream water bodies, including foreign organisations.

Additional existing information and analyses:

- Review existing analyses of water monitoring, status, management plans etc.;
- Information collected under existing European Community legislation (use register of protected areas, Article 6) and national legislation;
- Review whether available methods are capable of producing the required assessments.

Objectives (Article 4)::

- Determine objectives pertinent to water body.
- Assess the existing monitoring data (biological, physico-chemical and hydromorphological), against the environmental objectives, or assumed equivalent objectives;
- Consider if analogous catchment approach helpful.

Pressures and impacts analysis, to be complete by 2004::

- Develop appropriate conceptual understanding considering characteristic of water body, catchment area, activities, driving forces, pressures, and objectives;
- Select appropriate tools based on conceptual understanding and data availability;
- Assess vulnerability of water body and dependent water bodies to impact from the identified pressures, to assess whether the water body is at risk of failing to achieve objectives;
- Explore the variability of pressures and impacts within the catchment of the water body – variability may indicate that it would be helpful to subdivide the water body for the purpose of developing a practical programme of measures;
- Ensure variability is not caused by uncertainty in source data or methods;
- Take forward the analysis by exploring changes and trends in activities and pressure anticipated in the period to 2015 and beyond;
- If failure is likely, review exemptions that may be applicable (provisional identification as heavily modified Article 4.3, temporary deterioration Article 4.6).;
- Review all steps above as (i) more, or better, data become available, (ii) new assessment tools become available, and (iii) as experience and expertise develop.

Outputs:

- Report on pressures and impacts analysis within 3 months of completion (Article 15, Chapter 3.10).;
- First list of water bodies “at risk”;
- Use the results of the analysis to inform development of monitoring programme (Article 8) and programme of measures (Article 11).

3.12 Review for groundwater

A summary checklist of key tasks for the characterisation of groundwater bodies appears in the following text box.

Summary of key tasks for groundwater

Initial characterisation.

Using existing data:

- Collate data on pressures on the groundwater body, taking particular regard to those pressures listed under Annex II, 2, 2.1;
- Collate information on impacts on the groundwater, taking particular regard to those pressures listed under Annex II, 2, 2.1, and having special regard to the natural condition;
- Review existing groundwater monitoring data (chemical and water level), and data on dependent surface waters and ecosystems, having regard to the known pressures and impacts on the groundwater body, and the environmental objectives that are relevant to the body (Art. 4).;
- The development of a conceptual model of the groundwater flow, which also incorporates flow to/from associated surface waters, and a model for the chemical system are recommended as the basis for understanding and documenting the groundwater body, and to aid decision making;
- Assess vulnerability of groundwater to pollution from the recorded pollution pressures, to assess whether the groundwater body is likely to be at risk of failing to achieve good chemical status;
- Assess the water balance of the groundwater body, having regard to the recorded quantitative pressures, to assess whether the groundwater body is likely to be at risk of failing to achieve good quantitative status;
- Consider possible relationships between the groundwater body and connected wetlands;
- Consider both chemical and quantitative status to decide whether the groundwater body is likely to be at risk of failing to achieve good status, including an assessment of time-lag of pollutants in aquifers;
- A review of the delineation of the groundwater body may be undertaken if the data on pressures and impacts indicates that it may be helpful to subdivide bodies for the purpose of developing a practical programme of measures. However, any subdivision should conform to the 'rules' on groundwater body definition contained within Commission guidance.

Where there are no monitoring data for a groundwater body, the likely presence or absence of pressures and impacts should be considered when making a decision of the likely status of the groundwater body. Where it is clear from monitoring data that the groundwater body is 'at risk', or where there is inadequate data to make a decision with reasonable confidence that a groundwater body is 'at risk', the process should continue to Further Characterisation.

Further characterisation.

The key stages replicate Initial characterisation but relies on additional data and more sophisticated analysis techniques.

4. Tools to assist the analysis of pressures and impacts

4.1 Introduction and Overview

This Chapter focuses on the tools needed to carry out the General Approach as outlined in Chapter 3 and mentions some of those tools already available. At present there is no single tool capable of performing a complete pressure and impacts analysis for all types of water body, and it is very unlikely that such a tool will eventually exist. Therefore, this Guidance describes specific tools that consider one particular component of the process or environment (e.g. pressure assessment, surface water, groundwater, biology). The results from more than one tool may have to be integrated to undertake a complete pressure and impact analysis of a water body.

Before using any tool you must be sure that it is fit for the purpose for which you want to use it. You should have a clear objective defined, i.e. what questions you want to answer, and should select a tool that is capable of simulating the pressure and impact being considered and of providing the required results. You should be aware of the capabilities and limitations of each tool. The Guidance gives hints for those decisions.

In each Section and the Annex IV one or more example tool or model is described, but it is necessary to stress that they are just that – *examples not* IMPRESS *recommended or endorsed tools*. Most of the tools described are currently used within member states for functions similar, or possibly identical, to those required by the WFD, and in general such usage was mandatory for a tool to be included. Many more tools exist, and no doubt will become available in the future.

To be included in this Guidance the tool must to some degree be formalised into a set of rules or procedures. However, these will have been based on some form of expert judgement, perhaps in the form of, for example, a consensus widely held amongst practitioners, the current state of scientific knowledge, or an individual’s experience and expertise. It would be wrong, therefore, to think that the tools described here are necessarily better than the expert judgement of the individual undertaking the pressure and impacts analysis. The value of local knowledge and experience should not be underestimated or dismissed in favour of a more formal process imported from elsewhere. Those undertaking the analyses should consider involving stakeholders since they are likely to introduce complementary knowledge and experience.

The toolbox considers a pressure checklist (Section 4.2) and screening approaches (Section 4.3). The pressure checklist contains an uncompleted list of pressures that should be considered as part of the pressures and impacts assessment. The use of screening techniques is understood to be most helpful in the short-term implementation of the Directive. The corresponding Section focuses on examples of how to use certain techniques with the aim to simplify the approach of the analysis.

The general approach is based on a logical succession of key stages, which realisation requires full availability of data and tools. In contrast, Section 4.4 also considers the current state, where a great deal of these required means is not available, or just not identified. Hence, it focuses on the identification of the tools that are required to respond to specific questions. This identification is carried out by analysing the relationships between pressures and impacts as well as those between state and impacts, as regards the objectives of the Directive.

In Section 4.4 the need for tools is compared with the existence. This is clustered into three categories:

1. The fully available tools, that have been to some degree formalised into a set of rules or procedures. These tools are, when possible, exemplified through their actual application that includes the conditions under which they can be applied. In this case, full description is presented in Annex IV;
2. Tools still being at a laboratory or pilot stage. This category includes defined methods which have not yet been implemented into an operational system. They require further development and engineering to be operational. However some tools can be replaced by some form of expert judgement;
3. The non existing tools. In this case, the need for development, possibly including research is indicated to pinpoint the possible gaps in application.

The Annex V contains four Sections that relate to types of tool identified within the General Approach. These types are:

- Pressure screening and assessment;
- Quantification of pollution pressures;
- Tools to combine pressures with impact assessment - Water body models; and
- Impact assessment.

4.2 Pressure Checklist

The pressure checklist contains an uncompleted list of pressures that should be considered as part of the WFD pressures and impacts assessment. The list can be considered as a reminder of the driving forces and the pressures that should be considered and therefore represents a precursor to the actual pressures and impacts analysis. The driving forces and pressures within this table are listed mixed and independent from whether paths, or sources of substance entries etc. are mentioned.

The pressure checklist is presented in two stages. First, in Table 4.1 the pressures have been grouped into four main classes of driving forces that may impact the different water body categories and prevent them from meeting the objectives. A tentative indication of these likely-to-be relationships is reported in the Table 4.1. This table is an entry to the following uncompleted list of pressures in Table 4.2, as the numbers in the first column of Table 4.1 refer to the corresponding lines in Table 4.2. Please note that Table 4.2 mirrors the structure of Table 3.1.

Table 4.1 Pressures to be considered. See Table 4.2 for more details.

n°	DRIVING FORCES	Water Body Category: Rivers	Lakes	Coastal/Transitional	Groundwater	OBJECTIVES: WFD (biota)	Tap water, NO3	Bathing, recreation	Habitats, Birds	Shell/fish farming
10	**Pollution**									
11	Household	x	x	x	x	x	x	x		
12	Industry (operating, historical)	x	x	x	x	x	x			
13	Agriculture	x	x	x	x	x	x	x	x	
14	Aquiculture /fish farming	x		x		x				
15	Forestry	x	x	x	x					
16	Impervious areas	x	x	x		x		x		
17	Mines, quarries	x			x	x				
18	Dump, storage sites	x		x	x	x			x	
19	Transports	x		x					x	
20	**Alteration of hydrologic regime**									
21	Abstraction (agri, industry, household)	x	x		x	x	x			x
22	Flow regulation works	x		x		x			x	
23	Hydropower works	x		x		x			x	
24	Fish farming	x				x				
25	Cooling	x								x
26	Flow enhancement (transfers)	x			x	x			x	
30	**Morphology (changes in)**									
31	Agricultural activities	x	x	x		x			x	x
32	Urban settlements	x	x	x		x	x		x	
33	Industrial areas	x	x	x		x			x	
34	Flood protection	x		x		x				
35	Operation, maintenance	x		x		x				
36	Navigation	x		x					x	
40	**Biology**									
41	Fishing/angling	x	x	x		x				
42	Fish/shellfish farming	x	x	x		x				x
43	Emptying ponds	x	x						x	x

Table 4.2 Uncompleted list of Pressures to be considered

n°	SOURCE	Source within the source type
10	DIFFUSE SOURCE	
12	urban drainage (including runoff)	industrial/commercial estates
11		urban areas (including sewer networks)
16		airports
19		trunk roads
19		railway tracks and facilities
19		harbours
13	agriculture diffuse	arable, improved grassland, mixed farming
13		crops with intensive nutrient or pesticide usage or long bare soil periods (e.g. corn, potato, sugar beets, vine, hops, fruits, vegetables)
13		over grazing – leading to erosion
13		horticulture, including greenhouses
13		application of agricultural waste to land
15	forestry	peat mining
15		planting/ground preparation
15		felling
15		pesticide applications
15		fertilizer applications

n°	SOURCE	Source within the source type
22		drainage
19		oil pollution
11	other diffuse	sewage sludge recycling to land
		atmospheric deposition
19		dredge spoil disposal into surface waters
19		shipping/navigation
	POINT SOURCE	
11	waste water	municipal waste water primarily domestic
11		municipal waste water with a major industrial component
11		storm water and emergency overflows
11		private waste water primarily domestic
11		private waste water with a major industrial component
19		harbours
12	industry	gas/petrol
12		chemicals (organic and inorganic)
12		pulp, paper & boards
12		woollens/textiles
12		iron and steel
12		food processing
12		brewing/distilling
12		electronics and other chlorinated solvent users
12		wood yards/timber treatment
12		construction
25		power generation
12		leather tanning
19		Shipyards
12		other manufacturing processes
17	mining	active deep mine
17		active open cast coal site/quarry
17		gas and oil exploration and production
15		peat extraction
17		abandoned coal (and other) mines
17		abandoned coal (and other) mine spoil heaps (bings)
17		tailings dams
18	contaminated land	old landfill sites
18		urban industrial site (organic and inorganic)
18		rural sites
18		military sites
13	agriculture point	slurry
13		silage and other feeds
13		sheep dip use and disposal
13		manure depots
12		farm chemicals
19		agricultural fuel oils
19		agricultural industries
18	waste management	operating landfill site
18		operating waste transfer stations, scrap yards etc.
18		application of non agricultural waste to land
14	aquaculture	land based fish farming / watercress / aquaculture
14		marine cage fish farming
12	manufacture, use and emissions from	priority substances
12	all industrial/agricultural sectors	priority hazardous substances
12		other relevant substances
	ABSTRACTION	
21	reduction in flow	abstractions for agriculture
21		abstractions for potable supply
21		abstractions by industry
24		abstractions by fish farms
23		abstractions by hydro-energy
21		abstractions by quarries/open cast coal sites
22		abstractions for navigation (e.g. supplying canals)
20	ARTIFICIAL RECHARGE	
26		groundwater recharge
30	MORPHOLOGICAL	
22	flow regulation	hydroelectric dams
21		water supply reservoirs
22		flood defence dams

n°	SOURCE	Source within the source type
22		diversions
22		weirs
36	river management	physical alteration of channel
35		engineering activities
31		agricultural enhancement
31		fisheries enhancement
32		land infrastructure (road/bridge construction)
36		dredging
36	transitional and coastal management	estuarine/coastal dredging
36		marine constructions, shipyards and harbours
31		land reclamation and polders
30		coastal sand suppletion (safety)
30	other morphological	barriers
	OTHER ANTHROPOGENIC	
12		litter/fly tipping
11		sludge disposal to sea (historic)
33		mine adits/tunnels affecting groundwater flows
40		exploitation/removal of other animals/plants
10		recreation
41		fishing/angling
40		introduced species
40		introduced diseases
10		climate change
31		land drainage

4.3 Screening approach within the general approach

The objective of the screening approach is to point out with simple assessments those water bodies that are clearly "at risk" or "not at risk" of failing to meet the objectives in 2015. This may happen either if the current state is good enough *or* too bad, *and* if there is no expected change in pressures. Compared to the general approach, the screening approach may be carried out in any order (assess state, assess lack or certainty of impact), using driving force assessment as substitute of pressures. Consequently, the screening approach preferably stands on existing data, not on modelling; otherwise the required transparency of the approach would not be met.

Three examples of screening techniques should be mentioned for the following cases:

1. If only pressure data are available, their screening can be used as hint of a risk of failing objective;
2. If driving forces are correctly assessed and computed on small areas, and can be used to stratify observation data;
3. If only observation data (state) is available. In this case, a pressure analysis supposed to be applied where unwanted state is observed

<u>*Examples for Case 1:*</u> In case state data are not sufficient enough to assess actual impact, techniques using only pressure data must be used. The LAWA pressure screening procedure was developed for the purpose of compiling the significant pressures, indicating which water bodies might be at risk and which elements of status (biological, substances) are to be considered in the monitoring programme. In some cases, data that have already been compiled on the basis of other directives (e.g. urban wastewater directive) can be used. This procedure is a useful check-list of what is likely to have an impact.

A second part of this LAWA screening procedure is mentioned in the Annex dealing with the assessment of impacts.

Table 4.3 Example criteria for significant pressures: German LAWA Pressure screening tool

Pressures: point sources	**Criteria**
Public sewage-treatment plants >2000 PE (derived from Urban Wastewater Treatment Directive)	- Annual volume of water discharge; - Population (P) and population equivalents (PE); - Substance loads according to Annex I of the German Wastewater Directive; - Annual loads of priority substances, substances of the quality objective directive, and river basin-specific substances, insofar as these substances are limited by water directives.
Industrial direct discharge	- Statement of systems according to IPPC Directive = pollutants according to EPER; - Annual loads of plants with obligation to report according to IPPC Directive: consideration of the particular size threshold for the annual load of 26 substances (cf. Table 1: Size thresholds; EPER); - Annual loads of priority substances, substances of the quality objective directive, and river basin-specific substances, insofar as these substances are limited by water directives; - Food industry facilities >4000 EP.
Storm water / combined wastewater discharges	- Discharge of wastewater from an urban area >10 km^2; - Urban areas can be estimated e.g. basing on CORINE-landcover, multiplied with discharge coefficients.
Discharges with heat load	Discharges with heat load > 10 MW.
Salt discharges	Discharges > 1 kg/s chloride.
Pressures: diffuse sources	**Criteria**
Diffuse sources in general are surveyed while the inventory taking for groundwaters. Normally these data can be used also for the description of surface water bodies (this does not apply to erosion from surfaces with a gradient > 2%. If no results from description of groundwaters are available, the following values can be used for an estimation of diffuse pressures:	
	- Urban land > 15 % - Agriculture = 40 % - Sugar beets, potatoes and corn = 20%of agricultural land - Special crop land (vineyards, fruits, vegetables,..) = 5 % of agricultural land - Contaminated land = Individual case
Water abstraction	**Criteria**
	Abstraction without recirculation > 50 l/s
Water flow regulation	**Criteria**
Anthropogenic barriers	Parameter "anthropogenic barriers" (Stream habitat survey): ≥ 6
Backwater	Parameter "backwater" (Stream habitat survey): = 7
	Diversion stretches > x km
Morphological alterations	**Criteria**
Morphological alterations	Stream habitat survey and comparable data

The OECD-Vollenweider approach of lake classification was developed to assess the probability that a lake reaches a certain trophic state as a result of nutrient (principally Phosphorus) inputs. It can be used as screening tool, especially when the actual state can be compared with a possible natural one. The procedure is not longer described in this guideline, as it can be found in literature and national classification systems for lakes.

Example for Case 2: The EuroWaternet (EEA, see Chapter 6 and Annex V) uses the driving forces to stratify the pool of river monitoring stations. The representative observation data set obtained shows clear-cut differences in water quality according to the likelihood of pressures resulting from the presence of driving forces on catchments. Provided the basis for stratification is constructed with small elementary areas (e.g., in France, average size is 90 km^2), they constitute a proxy of the statistical population of water bodies catchments.

The representative observation data set can be used to assess time trends (for nitrate, ammonium, etc.). The use of simple filtering techniques allows to remove the interannual changes in river discharge, thus providing a statistical estimate of the trend under the "business as usual" scenario.

This approach uses only monitored data and simple driving force data, namely CORINE *land cover* and population census.

Example for Case 3: In case only monitoring data are available, the water quality classification results are usable as screening tools. Users will need to take account the limitations of these schemes in relation to the scope of the Directive's objectives. Requirements are listed in Chapter 3.5. Examples are included in the Annex to Chapter 4.

One Example – the German LAWA impact assessment tool - proposes to use thresholds for summaries of classification results for a water body as screening tools. Another example - the water quality accounts (WQA) technique (see Chapter 6) - may help to identify which kind of pressure is likely to be involved. The WQA processes quality indexes from the measured concentrations, thus making different water quality issues comparable, if the used classifications are comparable. The issues which determine the overall state of the water body can be pinpointed by comparing the water quality issues. Even though WQA and EuroWaternet start with the same data (from monitoring points), they yield complementary assessments of river quality issues that provide a powerful screening of water bodies causing problems.

The HMWB Guidance offers some tools to identify hydromorphological pressures and their impacts (see WFD CIS Guidance Document No. 4 on Heavily modified Water Bodies / HMWB). Chapter 3.4 and the Annex to Chapter 4 summarise the knowledge about main uses (driving forces), connected physical alterations and impacts.

4.4 Basic Considerations about Use of Numerical Models

Mathematical models of ecological, hydrogeological and geochemical systems may be used to simulate the movement of water, and the fate and transport of pollutants within water bodies. Models take a variety of forms and the question(s) that need to be answered (e.g. 'what is the likely chemical status of a groundwater body?'), the data availability and the time and funds available are all relevant considerations in deciding what complexity of model is used. In general the more complex the model, the greater the data requirements and the greater the time and costs needed to complete it. As a consequence, the accuracy of a robust numerical model may be greater than that which can be achieved using a simpler model. However, in the context of water body characterisation under the WFD there are many questions that may be answered adequately with a simple model.

An iterative approach is recommended, where assessors begin with simple conceptual understandings or analytical models and shift to mathematical models only where water bodies appear to be at risk, or where a detailed programme of measures is being developed. In many cases simple analytical models will be adequate to allow an assessment of contaminant behavior, however in certain situation more complex numerical models will be required.

Assessors may use numeric models to make predictions about combined point and diffuse source pollution effects on the wider groundwater body and on dependent surface waters and ecosystems, and to predict the effects of abstractions and artificial recharges on water resources. In addition, development of a numeric model helps assessors to:

- identify data and knowledge limitations;
- predict the impacts from a number of pollution pressures on remote receptors;
- predict the impacts from a number of abstraction or artificial recharge pressures on water resources, including any impacts on surface water bodies and dependent aquatic ecosystems;
- make predictions on the fate and transport of pollutants;
- include spatial and temporal variability in model predictions (which is often not possible with simpler analytical models).

4.5 Identification of tools: Comparison of need with existence and Examples

The IMPRESS guideline deals with impacts and pressures. Hence the tools are identified according to two leads: either they make it possible to quantify the pressure, supposedly leading to an impact or they enable to assess the state (the impact being assessed through change in state).

This identification is carried out for the main water body categories, i.e., rivers, lakes and ponds, groundwater and transitional waters. Some tools may obviously be common to several categories. To simplify the search, the pressures were grouped by identical function (e.g. nutrient discharges), notwithstanding the sources themselves.

The identification of tools is illustrated by constructing four matrixes, one per water body category. All tables have the same structure: the objectives are reported as column headers, and the pressures in lines. Each cell represents a "group of tools" that are understood to provide the expected information. The colour code of the cell qualifies the existence of at *least one tool* capable of quantifying the pressure and assessing the related impacts. Meaningless cells are indicated "NA for "not applicable". The state assessment is considered as a general tool related to category components, and is reported in a header line of each matrix.

4.5.1 Tools for rivers

Table 4.4 Assessment of the degree of availability of tools needed for riverine water bodies

RIVERS	WFD				Protected areas			
Tools categories : 1: Tools available and implemented 2:Tools available but not implemented 3: No available tool	Physico-chemistry	Flora	Invertebrates	Fish	Drinking water, nitrate	Bathing, recreation	Habitats, Birds	Remarks about methods and required data
Pressure quantification per pressure group								
POLLUTIONS								
Nutrients	1	2	2	2	1	1	NA	Moneris, Nopolu, Eurowaternet
General conditions	1	2		1	1	1	1	
Toxics	2	2	2	2	2	2	2	Only partial assessments
Pathogens	NA	NA	NA	NA	2	2	NA	
WATER REGIME								
Abstractions, derivation, storage		3	3	2	NA	NA	3	Tools do not encompass all uses
Change in flood regime	NA	2	2	2	NA	NA	2	Many indicators, no overall procedure nor local reference data
Change in low water regime	2	3	2	2	NA	NA	2	Only relationships with chemistry are documented, otherwise local expertise required
Hard change in discharge	2	3	2	2	3	3	2	Definitions to be formalised
MORPHOLOGY								
Break in longitudinal course	NA	NA	3	2	NA	NA	3	Indicators not available
Bed artificialisation	3	3	3	3	NA	NA	3	""
Maintenance, works in river bed	3	3	3	3	NA	3	3	""
Change in river course	NA	3	3	2	NA	NA	3	""
Change in facie*	3	3	3	2	NA	NA	2	""
Banks artificialisation	NA	2	3	2	NA	NA	3	""
Destruction /sealing of annexes	3	3	3	2	3	NA	3	""
BIOLOGY								
Direct capture	NA	NA	NA	2	NA	NA	3	Partial capture statistics
Fishing management	NA	NA	NA	2	NA	NA	NA	
Species introduction	NA	2	2	3	NA	NA	3	Links with nature conservation surveys to create
Introduction of diseases	NA	NA	NA	3	NA	NA	3	Poor documentation
State assessment	1	1	1	2	1	1	2	For instance LAWA, Finnish assessment tool, E&W grids, SEQ-eau. Water accounts and Eurowaternet to aggregate results.

Note, that existing classifications usually don't assess the difference of biological elements to the natural status as required by WFD, Annex V, 1.2. Therefore their results are of restricted value, but should be used in the first assessment in 2004 (further explanation in Chapter 3.6).

Pressure and impact quantification tools are available only for a *limited number of pressure types*, mostly dealing with organic and nutrient pollution loads. Considering the groups of tools, only 10% of these groups can be exemplified by implemented tools. On the contrary, a large number of groups (about 45% each) still require efforts either for implementation or scientific development, mainly in morphology linked assessments.

Quantifying the pressure would ideally be done using monitoring data. However such data do not exist in many circumstances, or are not monitored. Hence, the existing tools use alternative information to quantify the pressure. For agricultural pressure information on soil type, agricultural activity and management strategy are processed whereas for sewage effluents it might require the population equivalent of the inputs to the plant and the type of processing.

The output from the tool must be combined with another tool that combines the information on pressures, with a representation of the receiving water body. Thus, for example, the pressure resulting from an abstraction is first quantified, and then combined with information on a river system to determine the actual impact.

The currently implemented tools addressing **pollution pressures** (examples are taken from MONERIS, Nopolu, SENTWA, see Annex IV) are not fundamentally different. According to country requirements, and reporting needs, some processes are more or less detailed, as shown below, (more detailed presentation and references are provided in Annex IV):

- The German MONERIS (Modeling Nutrient Emissions in River Systems) estimates by various pathways the nutrient inputs into river basins of the German Baltic Sea catchment area. The model is based on a geographical information system (GIS), which includes digital maps as well as extensive statistical information and monitoring data in rivers, groundwater, drainage and point source effluents. The main pathways of water pollution are considered and, in the absence of ad hoc knowledge and data, they are processed thanks to lumped coefficients. One special feature of the model development is that the different sub-models were validated by using independent data sets, for example the groundwater model was developed with the observed nitrogen concentrations in the groundwater and not on the basis of the observed nutrient loads in the rivers;
- The Nopolu system encompasses a full description of the water-related characteristics of any territory, e.g. metropolitan France in which it is progressively implemented. Hydrologic and administrative apportionment relationships are managed by the system by the way of specific links (large cities discharging in a far away river) or by crossing information derived from GIS tables such as CORINE *land cover*. An important characteristic of the system is the possibility to aggregate and disaggregate results at any scale, thus responding to specific reporting requirement. The system is oriented towards assessment of state, pressure quantification and impact analysis, focusing on a thorough exploitation of observed data. The calculation of emissions aims at computing the real loads, taking stock of both monitoring data from large sources and statistical aggregates for area sources;
- The SENTWA model 'System for the evaluation of the nutrient transport to surface water' simulates the nutrient emissions from agriculture ("manuring") to surface water. It is a semi-empirical model that quantifies orders of magnitudes of nutrient emissions. It quantifies the load total N and total P (kg or ton N/P; kg or ton N/P per ha) on an annual or monthly basis and per river catchment in Belgian Flanders.

A current effort to compare models of pollution pressure by nutrients is carried out by the EUROHARP initiative (details are available on the http://www.euroharp.org site). Unfortunately, the work schedule does not match the 2004 reporting, but should help in later phases of the implementation of the directive.

A large number of tools for modelling impacts in rivers, of which SIMCAT (see annex) is an example, have been developed and calibrated. These models are however mostly developed to simulate physico-chemical mechanisms, and do not help assess the new issues introduced by the Directive.

No implemented tool capable of assessing the impact of changes in hydrological regime or morphology could be identified. However, the previous available discharge and elevation data could be used to design ad hoc indicators. For example, pike spawning conditions, fish ladder efficiency or dam filling impact, etc. can be assessed using statistics computed from daily discharge data and simple elevation – discharge relationships. The main gap is the current lack of reference data that apply to each considered water body: what is the water elevation over the meadow, what is the discharge on the equipped weir, how many "small" floods are there?

State assessment tools are often well documented and available. They use monitoring data which can be applied and the likely impacts derived from them.

Most countries have developed their own classification systems that show some differences in concept. The Finnish water quality classification system (see Annex IV) has been developed in order to give information on water usability for human purposes. It takes into account only ecological quality elements, which have a direct impact on water usability. It treats all water bodies similarly, not making any difference between different water categories or water body types. Classification is based mostly on chemical quality elements, but also on some biological elements such as hygienic indicators, chlorophyll and algal blooms. Criteria and threshold concentrations can be found in the Annex.

The England and Wales River Ecosystem Classification scheme, which thresholds are presented in the Annex, uses an 8 physico-chemical determinant grid that applies to monitoring points. The physico-chemical quantities used can be obtained from observed data or modeled output. Classes 1 and 2 are considered representing conditions suitable for salmonid and cyprinid fish populations.

The German assessment tool, set up by LAWA (State Working Group on Water) assesses the state of a water body from available environmental monitoring. Contrasting with other tools, it considers aggregated criteria, including the trophic state of the river network. An estimation of the probability that good ecological or chemical conditions will not be achieved within a period of observation is carried out according to the rule detailed in the Annex.

The French SEQ aims to consider all compartments of the water system (rivers, lakes, groundwater, transitional) and their components (water, biology, morphology). The state is assessed by comparing threshold values established for relevant groups of determinants considering the type of use. This approach takes stock of all available information and regulations, at the expense of a certain degree of complexity. More details are provided in Annex IV.

Summary related to tools suitable for rivers

Many tools are available, but unfortunately they focus on classical pollution that can be computed and modelled. Many developments are required for hydrological pressures. In this case, a common set of indicators could be defined, backed up by local identification of relevant threshold values. Morphology and biological pressures, that are not well understood, require developments to address ecological state assessment, including links with habitats and bird life in riparian areas.

4.5.2 Tools for lakes and ponds

Table 4.5 Assessment of the degree of availability of tools needed for lakes water bodies.

LAKES

Tools categories :
1: Tools available and implemented
2:Tools available but not implemented
3: No available tool

	WFD				Protected areas			
	Physico-chemistry	Flora	Invertebrates	Fish	Drinking water, nitrate	Bathing, recreation	Habitats, Birds	Remarks about methods and required data
Pressure quantification per pressure group								
POLLUTIONS								
Nutrient	1	1	NA	NA	1	NA	NA	OECD, Moneris, Nopolu
General conditions	2	2	3	2	1	2	3	
Toxics	2	3	3	2	2	3	3	
Germs	NA	NA	NA	NA	3	2	NA	
WATER REGIME								
Abstractions	2	2	3	3	NA	NA	NA	
Changes in high water period	2	3	NA	3	NA	NA	3	Some indicators
Change in low water period	2	3	3	3	NA	NA	3	
Withdrawal management	2	2	2	2	2	3	3	Local models
MORPHOLOGY								
Banks artificialization	NA	2	3	2	NA	NA	2	
Destruction of riparian areas	2	2	3	2	NA	NA	2	
BIOLOGY								
Direct captures	NA	NA	NA	2	NA	NA	3	
Management of fishing	NA	NA	NA	2	NA	NA	3	
Introduction of species	NA	3	3	2	NA	NA	2	
Diseases introduction	NA	NA	NA	2	NA	NA	3	
State assessment	2	1	3	2	1	1	2	Finnish assessment tool, SEQ-lacs.

Pressure and impact quantification tools quantifying pollution loads are no different from those applicable to rivers and they are not discussed again here. The most general tool providing impact assessment is the OECD model (known as "Vollenweider's model"), already mentioned in the "screening section". It can be used for more precise assessments than just screening, provided that more accurate input loads and renewal time are available.

Since many lakes result from dam construction, the impact of withdrawals on water quality has been investigated in many countries. Selective withdrawal models were used in the 1980's to implement dam management rules capable of changing the thermal stratification of stored waters and limit eutrophication.

In parallel, many studies were devoted to the understanding of the relationships between water level changes (due to water use) and the biological functioning of banks. The purpose was twofold: increase the amenity of the water body, especially during the tourist season, and lower the adverse impacts of reservoir construction.

Despite the fact that the results of these approaches cannot be considered as fully implemented tools, they can be used as basis for investigation, especially if the experts who worked on these water bodies are still in position to help implement the Directive.

State assessment tools are implemented on a routine basis in only a limited number of countries that monitor these waters. Most deal primarily with eutrophication issues, resulting in abundant literature. For assessment of the risk of failing objectives for waters used for drinking water and bathing, data on compliance with the EU-directives 75/440/EEC (surface water intended for abstraction of drinking water) and 76/160/EWG (bathing waters) could be used.

Summary related to tools suitable for lakes
Considering the groups of tools, virtually none can be exemplified by implemented tools. About half of them still require effort for implementation, the remaining requiring scientific development, mainly in hydrological regime linked assessments. Again there is a lack of tools describing impacts on the difference of species composition and abundance to the natural state of biological elements.

4.5.3 Tools for groundwater

Groundwater vulnerability maps or indices are useful tools for assessing the likely impact of pollution pressures during the characterisation process. By taking account of a range of factors, the susceptibility, or vulnerability, of groundwater to pollution from pollution pressure on the land surface can be ranked. Typically vulnerability-ranking methods take account of a range of parameters, including:

- Presence, nature and thickness of soils, including attenuating properties;
- Presence, nature and thickness of superficial (drift) deposits, including attenuating properties;
- Groundwater flow mechanism in the aquifer (e.g. matrix, fracture, dual porosity dominated);
- Depth to the water table.

Groundwater vulnerability maps, based on a regional assessment using an index-based system can be used as a screening tool to rapidly assess the relative scale of impacts arising from pressures. They may be useful for assessing whether groundwater bodies are 'at risk' from pollution sources at initial characterisation.

Groundwater vulnerability assessments may be combined with models of diffuse pollution source behaviour, such as those developed for nitrates in The Netherlands (**STONE;** details are available under the http://www.riza.nl/projecten_nl.html site) or for pesticides in the UK (**POPPIE;** details are available under the http://www.meds-sdmm.dfo-mpo.gc.ca/meds/Prog_Int/ICES/ICES_e.htm site), to consider the overall risks to water quality on a groundwater body scale.

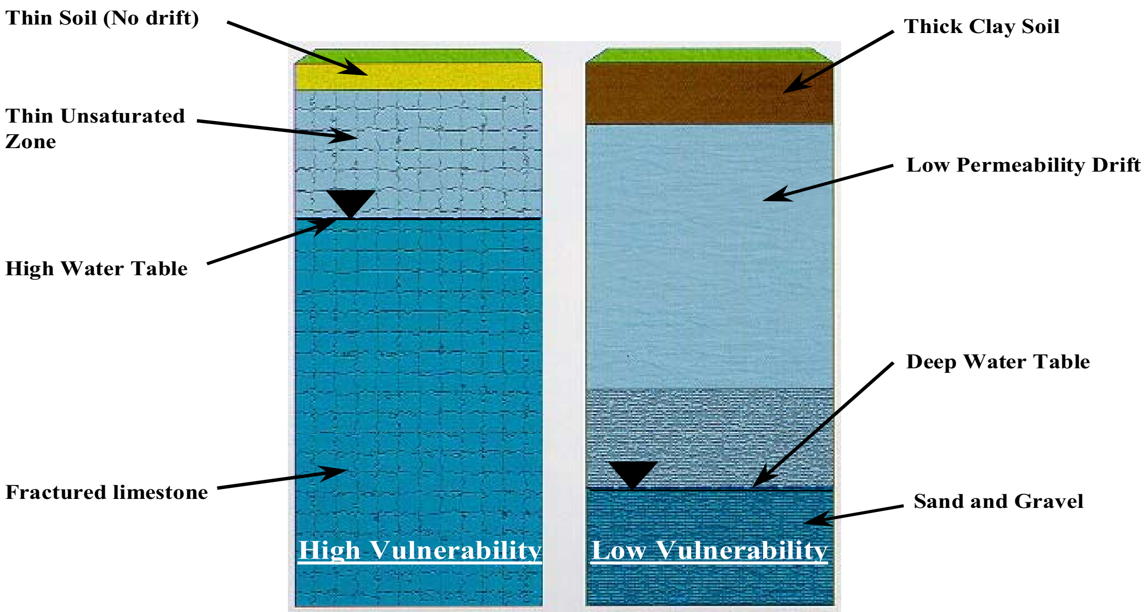


Figure 4.1 High and low vulnerability groundwater bodies (Courtesy of UK Groundwater Forum).

Groundwater models: Groundwater flow modelling is useful for three principal purposes. Firstly, it may be helpful for predicting the likely impacts of abstractions and artificial recharges on the groundwater body and associated water bodies, and subsequently assessing the whether the groundwater body is likely to achieve good quantitative status. Secondly, the development of a robust groundwater flow model is a necessary prerequisite to any contaminant transport modelling undertaken as part of the analysis of the pollution pressures on that body. Finally, the model is valuable later in the WFD process for developing an effective programme of measures and for management of the water body.

Groundwater flow models also, typically, simulate the interaction of groundwater with other parts of the hydrological cycle. Interactions between the groundwater and surface waters and wetlands may be simulated, which is vital for predicting the interactions between surface water bodies and their assigned groundwater bodies.
Groundwater resource models take many forms, from simple, normally analytical water balance models of the water inputs and outputs to a groundwater body, to complex numerical models of the groundwater flow system within a body.

Simple models include standard analytical solutions for the effects of abstractions of water table elevation. Commonly available tools such as **Aquifer Win**[32] (details are available on the http://www. aquiferanalysis.com/modelsum.thm site) and **P-Test** are already available that allow analysis of borehole pumping data to predict the impacts on water levels.

For regional studies or where more complex analysis is needed **MODFLOW** (details are available on the http://water.usgs.gov/software/modflow.html site) a numeric groundwater flow model produced by United States Geological Survey is widely used and is available as freeware. Alternative codes, such as **MIKE-SHE** (details are available on the http://www.dhisoftware.com/mikeshe/ site) are also used in a number of Member States to simulate groundwater flow on a catchment scale.

When the groundwater flow regime is understood it is possible to then consider the effects of pollution pressures. A range of tools already exist that may be helpful, including **ConSim** (details are available under the http://www.environment-agency.gov.uk/subjects/waters/groundwater site) an analytical model produced by the Environment Agency (England & Wales) that uses probabilistic techniques to predict the impact on groundwater quality from soil contamination and surface discharges. Where more complex codes are appropriate **MODFLOW** (details are available under the http://water.usgs.gov/software/modflow.html site) can be combined with freeware contaminant transport codes, **MT3D** or **MT3DMS** (details are available under the http://hydro.geo.ua.edu/mt3d/site) to predict the impacts from point source pollution. Proprietary pre-processors are also available for **MODFLOW**.

For diffuse pollution, existing numerical models are less helpful, however, groundwater vulnerability assessments are a valuable tool for assessing risks to groundwater quality in these circumstances. The Water Framework Directive does not differentiate between groundwater in different strata – all groundwater requires the same degree of protection from pollution. However, the impact that a pollution pressure is likely to have on groundwater varies from site to site, depending on the hydrogeological properties of the underlying soil, drift and solid geological strata. Consequently, for a given pollution pressure, the impact on the status of a groundwater body, and the potential programme of measures will vary in different aquifers.

4.5.4 Tools for transitional waters

State assessment tools are not yet fully developed, and maybe they are not completely defined since no full agreement exists across the scientific community. The best addressed issues are again those linked to causes of eutrophication and beneficial uses that are driven by obligations in relation with public health.

Pressure and impact quantification tools related to nutrient discharges were described in the river Section. The most prominent difference is the existence of the HARP/Nut and HARP/Haz guidelines agreed by the Ospar Convention, with the exception of Harp/Nut GL6, currently assessed within the Euroharp programme previously mentioned (see Annex).

The Harp/Nut guidelines are not a "tool", but they provide a coherent framework for quantifying the nutrient (and organic matter) loads discharged to sea and transitional waters, compared and calibrated with riverine fluxes where this comparison applies. This point is important to mention since the results are therefore very transparent, thus facilitating information of the public. The pollution assessment tools previously mentioned explicitly refer to these guidelines and compute outputs meeting the format requirements of the guidelines: by means (sewer, treatment plant, etc.) and by source (domestic, industrial, etc.) thus preparing the definition of measured programmes to combat pollution.

However, some adjustment should be made to allow reporting by water body, since Ospar asks for inputs to the sea only.

Table 4.6 Assessment of the degree of availability of tools needed for coastal & transitional water bodies.

COASTAL – TRANSITIONAL	**WFD**				**Protected areas**			
Tools categories : **1: Tools available and implemented** **2:Tools available but not implemented** **3: No available tool**	Physico-chemistry	Flora	Invertebrates	Fish	Shellfish farming	Bathing / recreation	Habitats, Birds	Remarks about methods and required data
Pressure quantification per pressure group								
POLLUTIONS								
Nutrients	1	2	3	2	2	3	3	Moneris, Nopolu, Harp/Nut
General conditions	2	2	3	2	2	3	3	
Toxics	2	3	3	2	2	2	1	Harp/Haz
Germs	NA	NA	NA	NA	NA	2	NA	
WATER REGIME								
Change in tidal regime	2	2	3	2	2	NA	3	Navigation works, large estuaries modifications
Change in drift currents repartition	2	3	3	3	2	NA	2	
Hard change in flow	3	2	3	2	2	NA	2	Applies to estuary damming
MORPHOLOGY								
Break in longitudinal course	NA	NA	3	2	NA	NA	3	
Maintenance, bed modification	2	2	3	3	NA	NA	2	
Change in shoreline	NA	3	3	3	2	NA	3	
Shore and coast artificialization	NA	2	3	3	NA	NA	3	Eurosion, in dev.
Change in hydro/sediment facies	3	3	3	3	NA	NA	3	Eurosion, in dev.
Intertidal area sealing	NA	2	2	2	2	NA	2	
BIOLOGY								
Direct captures	NA	NA	3	2	NA	NA	3	CIEM/ICES
Introduction of species	NA	3	3	3	NA	3	3	
Disease introduction	NA	NA	3	3	NA	NA	3	
State assessment	1	2	3	2	1	1	3	For instance SEQ-ETM

Important impacts on transitional waters are related to changes in hydrological and tidal regime resulting from river and estuarine damming and from harbours and navigation works. One example using expert judgement for impact assessment is included in the Annex to Chapter 6.

Summary related to tools suitable for coastal and transitional waters
There is a lack of pressure and impact assessment tools in this water body type. More than on half of the tool groups fall into the third case, where research is needed, the other half requiring implementation.

4.5 Summary conclusion

Even though the identification of available tools could not be completed, it can be clearly seen that many requirements of the directive cannot be addressed simply by selecting and implementing a purchased computer programme.

A positive conclusion is that the screening tools cover a reasonable spectrum of water body category, pressures and objectives. Some of them are capable of providing trend analysis, under the baseline scenario. In can therefore be expected that the analysis demanded in 2004 could mostly be fulfilled on the basis of existing tools.

The negative conclusion is that the original points of the directive, assessing the pressures that cause impact on biology and ecological status, are not covered by available tools and that their development will require research in many cases, not only engineering.

The points discussed in this Chapter deserve further investigation. It is suggested that the working group should keep in touch in order to share the experience of implementation. This would enable continued identification of the needs, availability and practicability of tools required to implement the guidelines.

5. Information needs and data sources

The description of the general approach required for the analysis of impacts and pressures has noted the many types of information and data that will be required. These can be divided into those that are generally descriptive of the drainage basin and its water bodies (i.e. they are not specifically related to either pressures or impacts), data that describe pressures, and data that describe impacts. Thus far the data requirements have been specified generally for surface waters, with rather greater detail for groundwaters.

With all information and data it is likely that the best and most readily accessible sources are national or regional datasets within the member state. It is ***not*** the intention of this Guidance to list such sources. The Guidance does indicate ***what*** types of data may be useful in the analysis of impacts and pressures, ***why*** the data may be useful, and gives a ***European-scale source*** for the information, if one exists. Therefore the column "Source" in the following tables is not filled in completely. Competent authorities undertaking pressures and impacts analysis may need to be innovative in order to collect sufficient data, for example by asking stakeholders groups who may hold useful records (fishermen and angling groups will hold data about fish catches, for instance; local wildlife groups will hold useful ecological data).

It is recommended that, where possible, data is collected in digital form and used within a GIS.

ANNEX II, 1.1 "Characterisation of surface water body types" and 1.2, "Ecoregions and surface water body types" are assumed to have been completed before the pressures and impacts analysis begins. Therefore this Chapter focuses on sources of information relevant to 1.4, Identification of Pressures, and 1.5, Assessment of Impacts.

The type of data, which has to be collected, shall at first consist of data about the water body (type, morphology, geographical and meteorological terms, biological and physico-chemical conditions), because this is the starting point for an analysis of pressures and impacts. In addition data about the existing uses (data about pressures from urban, industrial and agricultural point and diffuse sources, about water abstractions, water flow regulation, morphology and land use) and about the state of a water body are necessary.

Because of the short timetable for completion of the first pressures and impacts analysis, this should mainly use existing data, collected on the basis of criteria which are suitable for execution, supplementing this with newly gathered information where necessary. The collected data can be used according to Chapter 4 (Tools) for the pressure and impact analysis. To assess the risk of failing the environmental objectives, the ecological status and therefore the biological and chemical status and the vulnerability of a water body must be evaluated. Data must be collected which provide a description of the water body and its catchment, an identification of the anthropogenic pressures and an estimation of the impacts on the basis of monitored biology and chemistry.

Each Member State will have differing types, sources and amounts of information. It is possible to identify a number of categories of data which will be common for all Member States. An important category are the other existing EC Directives, partly mentioned in the WFD, Annex II, 1.4. These directives provide information on a particular type of pressure (e.g. the Urban Waste Water Directive) or they contain environmental standards (e.g. the Nitrate Directive). Such directives provide information on different pressures. Other types of information can be existing National Requirements, such as National Classification Schemes, inventories required by National Legislation, etc.

In Table 5.2.1 "Information of pressures" and Table 5.2.2 "Information of impacts" the directives which are mentioned in the WFD Annex II, 1.4 and therefore must be considered, are listed first.

5.1 General Information

5.1.1 Descriptive information relevant to waterbodies

Data type	Use	SW	GW	Source
Water bodies				
Type of water body	Starting point for pressure and impact analysis.	✓	✓	
Spatial extent		✓	✓	
Meteorological				
Rainfall	Water balances.	✓	✓	National Meteorological Services, EEA, other European
Temperature		✓	✗	
Geographical				
Topography	Identify drainage areas for water bodies.	✓	✓	Mapping services, EEA, other European
Solid geology	Aquifer characteristics. Water chemistry	✓	✓	National Geological Surveys and Institutes
Drift geology	Vulnerability of underlying aquifer. Run-off and drainage characteristics of catchment	✓	✓	National Geological Surveys and Institutes
Soils	Vulnerability of underlying aquifer. Run-off and drainage characteristics of catchment	✓	✓	National Soil Surveys and Institutes
Soil slope (%)	Run-off and drainage characteristics of catchment	✓	✗	
Channel morphology, nature of seabed	Estimate the status and the susceptibility of a water body or to assess pressures	✓	✗	
Land use				
Urban areas	Preliminary screening for point pollution sources.	✓	✓	National and regional statistical services, CORINE-Landcover (EEA)
Agriculture	Preliminary screening for point and diffuse pollution sources.	✓	✓	Agricultural administration, ,National and agricultural services, CORINE-Landcover, (EEA)
Industrial land	Preliminary screening for point pollution sources.	✓	✓	CORINE-Landcover, (EEA)
Mining/quarrying	Preliminary screening for point pollution sources	✓	✓	
Commercial forestry	Preliminary screening for point and diffuse pollution sources.	✓	✓	CORINE-Landcover, (EEA)

Data type	Use	SW	GW	Source
Fallow land	Preliminary screening for diffuse pollution sources.	✓	✓	CORINE-Landcover (EEA)
Recreation, e.g. golf courses	Preliminary screening for point and diffuse sources	✓	✓	
(Pattern of utilisation)	Preliminary screening for point and diffuse pollution sources.	✓	✓	

5.1.2 Key stakeholders that could be involved in the IMPRESS analysis

Key Stakeholders	Where they can help with information and expertise
Experts from Ministries (agriculture, transport, planning, economy,…	➢ Provide data for characterisation (for both groundwater and surface water):: - hydrological knowledge on behaviour of (ground) water bodies; - driving forces; - pressures; - changes in the state of the water body; - the impact of the pressures on the water status. ➢ Identification of key stakeholders; ➢ Assessing implementation and effect of existing community legislation, in general but also in relation to protected areas; ➢ Characterising water uses and their importance with regard to pressures; ➢ Defining coherent methodologies for assessing key variables at Member State level.
Water Service Suppliers , Water using sectors & stakeholders (farmers, industrialists, etc.)	➢ Provide data for characterisation (see above); ➢ Provide input for assessment of pressures.
Environmental NGOs	➢ Identifying key environmental issues; ➢ Assessing environmental impacts.
Stakeholders/civil society/public	➢ Providing specific input for the assessment of pressures.
Researchers/Experts (usually as consultants of the mentioned stakeholders)	➢ Assessing the impacts of pressures on water status (e.g. via modelling).

5.2 Information on pressures

5.2.1 Information on point sources of pollution

Data type	Use	Source
Urban Wastewater Directive (91/271/EEC) Data and Reports	Assessment of Urban Wastewater sites and their discharges. The monitored parameters are BOD5, COD, total suspended solids and for discharges to sensitive areas which are subject to eutrophication total phosphorus and total nitrogen.	National Data Storages and Reports
Integrated Pollution Prevention Directive (96/61/EC) Data and Reports	Collate sites authorised under the IPPC Directive and their discharges. At further characterisation consider detailed nature of activity.	National Data Storages and Reports, EPER

Data type	**Use**	**Source**
Activities authorised for purpose of Directive 76/464/EEC – Water pollution by discharges of certain dangerous substances	Collate locations of activities authorised under this Directive. At further characterisation consider detailed nature of activity	National Data Storages and Reports, EPER
Drinking Water Directive 75/440/EC	Information on quality of surface waters which are used as drinking water (physical, chemical and microbiological parameters are observed at regular intervals)	National Data Storages and Reports
Bathing Water Directive 76/160/EEC	Information on water quality of water bodies which serve as bathing waters (microbiological, physical, chemical parameters and other substances, which indicate pollution, are observed)	National Data Storages and Reports
Directive 78/659/EEC on the quality of fresh waters needing protection or improvement in order to support fish life	Information on the quality of fresh waters (physical and chemical parameters are observed) regarding fish life	National Data Storages and Reports
Directive 79/923/EEC on the quality required of shellfish waters	The Directive set the minimum quality criteria which must be met by shellfish waters (coastal and brackish waters): the physico-chemical and microbiological parameters; the mandatory limit values and the guide values of these parameters; the minimum sampling frequency and the reference methods of analysis of these waters.	National Data Storages and Reports
Activities authorised for purpose of the Groundwater Directive (80/68/EEC)	Collate locations of activities authorised under the Groundwater Directive. At further characterisation consider detailed nature of disposal activity	National Data Storages and Reports, EPER
Agricultural fertiliser application / sales data. Use data where readily available.		Agricultural administration
Activities authorised for purpose of Directive 1999/31/EC	Directive on the landfilling of waste. The Directive provides information on the amount of waste ending up at landfill sites. Collate locations of activities regulated for the Directive on landfilling. At further characterisation consider detailed nature of activity.	National Data Storages and Reports, EPER
Sites regulated under Major Accidents Hazards (Seveso) Directive (96/82/EC)	The aim of the Directive is the prevention of major accidents. This involves dangerous substance limitation. Collate locations of activities regulated for the Major Accidents Hazards Directive. At further characterisation consider detailed nature of activity.	National Data Storages and Reports, EPER
Nitrate Directive (91/676/EEC) designated areas	Assessment of releases of agricultural nitrates	National Data Storages and Reports
OSPAR Guidelines for Harmonised Quantification and Reporting Procedures for Nutrients (HARP-NUT)	Assessment of nitrate discharges	National Data Storages and Reports
OSPAR Guidelines for Harmonised Quantification and Reporting Procedures for Hazardous Substances (HARP-HAZ)	Assessment of discharges of hazardous substances	National Data Storages and Reports
Animal disease epidemic burial pits	Identify locations of burial of significant numbers (>50) of animal carcasses for	Veterinary surveillance

Data type	Use	Source
	disease control purposes	
Known point sources from contaminated land, old landfills, mines etc.	Identify key sites that are likely point sources, but are not regulated under above directives	
Storm-water overflows from sewerage systems	Identify storm overflows that discharge to ground	Water management administrations
Sub-aerial deposition	Identify regions subject to atmospheric deposition (e.g. acid rain)	
Railway lines (herbicides) and road verges	Identify railway lines and herbicides applied	
Oil distribution pipelines	Identify location of sub-surface oil pipelines	
Soakaways from major roads	Identify where major highways (motorways etc.) drain to ground. At further characterisation identify pollution prevention measures.	
Potentially polluting activities (e.g. industry, opencast mining, petrol stations)	Identify areas where there are numerous potential point sources	
Rates of discharges to ground	Further detail on discharges identified above (further characterisation)	
Chemical composition of discharges	Effluent composition (further characterisation)	

5.2.2 Information on diffuse sources of pollution

Data type	Use	Source
Nitrate Directive (91/676/EEC) designated areas	Identify areas of aquifer with high, or rising, nitrate concentrations	National Data Storages and Reports
Pesticides Licensing Directive (91/414/EC)	Information on pesticide usage	Pesticide Licensing Administrations
Directive 98/8/EC on Biocidal Products	Information on usage of Biocidal Products.	National Data Storages and Reports
Drinking Water Directive 75/440/EC	see 5.2.1 "Point sources" (some of the mentioned data can give information on different pressures or impacts, so they possibly are listed multiple)	National Data Storages and Reports
Bathing Water Directive 76/160/EEC	see 5.2.1 "Point sources"	National Data Storages and Reports
Directive 76/464/EEC – Water pollution by discharges of certain dangerous substances	see 5.2.1 "Point sources"	National Data Storages and Reports
Directive 78/659/EEC on the quality of fresh waters needing protection or improvement in order to support fish life	see 5.2.1 "Point sources"	National Data Storages and Reports
Directive 79/923/EEC on the quality required of shellfish waters	see 5.2.1 "Point sources"	National Data Storages and Reports
Agricultural fertiliser application / sales data. Use data where readily available		Agricultural administration
OSPAR Guidelines for Harmonised Quantification and Reporting Procedures for Nutrients (HARP-NUT)	Assessment of nitrate entries	National Data Storages and Reports
OSPAR Guidelines for Harmonised Quantification and Reporting Procedures for Hazardous Substances (HARP-HAZ)	Assessment of entries of hazardous substances	National Data Storages and Reports
Sub-aerial deposition (EMEP)	see 5.2.1 "Point sources"	

Data type	Use	Source
Railway lines and road verges (herbicides)	see 5.2.1 "Point sources"	
Oil filled pipelines	see 5.2.1 "Point sources"	
Chemical composition of discharges	see 5.2.1 "Point sources"	

5.2.3 Information on water abstraction

Data type	Use	Source
Water abstractions in the RBD: - amount of abstraction; - mean daily flow and low-flow river discharge; - lake level changes; - physico-chemical conditions; - sediment conditions; - existing or proposed schemes for artificial recharge of groundwater; It has to be considered that water abstractions possibly can be illegal.	Identify (or estimate in the case of illegal abstractions) abstractions with significant effect on the water body (water resources, chemical status, morphology)	Water management administrations, drinking water supply companies
Water abstraction in the RBD used for potable supply	Identify individual abstractions used for potable supply abstracting > XX m^3/d or supplying > XX persons. Needed to identify drinking water protected areas	Water management administrations, drinking water supply companies
Drinking Water Directive 75/440/EC	Possible information on locations of abstracted water	National Data Storages and Reports
Activities authorised for purpose of Directive 80/68/EEC	Collate locations of activities authorised under the Groundwater Directive. At further characterisation consider detailed nature of activity	National Data Storages and Reports

5.2.4 Information on water flow regulation

Data type	Use	Source
Information on changes in the natural flow regime or of groundwater level	Identifying regulations with significant effect on natural flow regime or groundwater level	Water management administrations
Amount and succession of weirs in the RBD	Assessment of river continuity for water organism.	Water management administrations, navigation authorities
Number and capacity of reservoirs in the RBD	Assessment of river continuity and natural flow regime	Water management administrations
Not passable artificial barriers, e.g. dams	Assessment of river continuity for water organism.	Water management administrations
Range of backwaters	Assessment of river continuity for water organism.	Water management administrations
River profile, river bank structures / Stream habitat survey	Assessment of morphology and possible impact on biology	Water management administrations
Groundwater level		Water management administrations
Flow regulation with flow spills		Water management administrations
Flood-protection structures	Assessment of morphology and possible impact on biology	Water management administrations

5.2.5 Information on morphological pressures

Data type	Use	Source
River bank structures / Stream Habitat Survey	Assessment of morphology and possible impact on biology	Water management administrations
Amount and succession of weirs in the RBD	See 5.2.4."Water flow regulation"	Water management administrations, navigation authorities
Range of backwaters	See 5.2.4."Water flow regulation"	Water management administrations
Not passable artificial barriers	See 5.2.4."Water flow regulation"	
River profile	See 5.2.4."Water flow regulation"	
Flood-protection structures	See 5.2.4."Water flow regulation"	
Development on floodplains		

5.2.6 Information on pressures from land use patterns

Data type	Use	Source
Urban areas	Estimation of substance entries, modified flow regimes, soil erosion etc.	Agricultural administration, National data storages, National and regional statistical services, National and agricultural services, CORINE-Landcover
Agriculture (if possible subdivided in: · Cultivated land; · Sugar beets, potatoes & corn; · Special crop land; · Animal unit equivalents per hectare);		
Industrial land		
Mining, quarrying		
Recreation, e.g. golf course, aquatic theme parks		
Commercial forestries		
Fallow land (Pattern of utilisation)		

5.2.7 Information on other pressures

Data type	Use	Source
Other existing EC legislation		National Data Storages and Reports
Polders / reclaimed land		
Invasive species		Nature authorities and wildlife groups
Artificial recharges of groundwater in the RBD	Identify artificial recharge schemes to ascertain impact on groundwater levels; groundwater contamination	Water management administrations

5.3 *Information on impacts*

5.3.1 Information on susceptibility / vulnerability of water bodies

Data type	Use	Source
Statistical climate data	Information on susceptibility of water bodies, e.g. regarding substance- or heat-discharger	Climatic data
Stream Habitat Survey (rivers) including depth, amount of weirs etc.	Characterisation of rivers	Environmental data
Flow rates (rivers)	Characterisation of rivers	Measurement of discharge
Morphology (lakes): - mean water depth - mean water width - type of stratification (mixis)	Characterisation of lakes	Environmental data

Data type	Use	Source
- volume, residence-time (Vollenweider-model)		
Groundwater vulnerability data	Data on soil and drift presence and type. Depth to water table. Groundwater flow mechanism (e.g. fracture or matrix flow dominated system)	National Geological or Soil Survey / Institute)
Directives on Bathing Water (76/160/EEC) and Drinking Water (98/83/EC)	Susceptibility due to the existing uses.	National Data Storages and Reports
Birds directive (79/409/EEC)	Possible information on vulnerability of the area	National Data Storages and Reports
Natural habitats of wild fauna and flora Directive (92/43/EEC)		
Measurements of concentrations of possible pollutants in a water body	Information on susceptibility of the water body regarding pollutant discharges	Environmental data

5.3.2 Environmental data

Data type	Use	Source
Directives on Bathing Water (76/160/EEC) and Drinking Water (98/83/EC)	Assessment of status.	National Data Storages and Reports
Criteria according to the Fish-Life-Directive 78/659/EEC	Observation underneath relevant heat-discharger, regarding the temperature	National Data Storages and Reports
Physico-chemical substances Annex VIII of the WFD and criteria given by the 76/464/EEC-Directive	Assessment of chemical status	National Data Storages and Reports
Groundwater quality monitoring data - substances with article 17 standards; - conductivity; - substances relevant for article 4 objectives of dependent systems.	Review existing data from groundwater abstraction and monitoring boreholes for evidence of impacts	National water quality monitoring programmes; requisite surveillance of activities under Directive 80/86
Information on the chemical status of the water body from e.g. National Classification Schemes, "State of the environment" type reports, etc.	Assessment of chemical status	National Data Storages and Reports
Information on the biological status of the water body from e.g. National Classification Schemes, "State of the environment" type reports, etc.	Assessment of status	National Data Storages and Reports
Information on e.g. animal and plant species from International conventions such as the Ramsar Bureau, the Emerald network, information that has been gathered or other classifications such as UNESCO World Heritage Sites, Biosphere Reserves etc.	Assessment of status	
Phytoplankton (ANNEX V, WFD) - Trophic status	Assessment of eutrophication.	
Macrophytes and Phytobenthos (ANNEX V, WFD)	Assessment of morphology and organic pressures	Environmental surveillance, including that by wildlife groups

Data type	Use	Source
Benthic invertebrate Fauna (ANNEX V, WFD): - Saprobic status; - AQEM-Evaluation.	Assessment of organic pressures	Environmental surveillance, including that by wildlife groups
Fish fauna: Species composition and abundance	Assessment of the river-continuity and morphology	Environmental surveillance, including that by wildlife groups, fisherman, angling groups, etc.
Stream habitat survey	Assessment of the morphology of rivers	Water management administration

6. Examples of current practice relevant to the WFD pressures and impacts analysis

Annex V contains case studies presented by members of the IMPRESS working group as examples of current practice (summarised in Table 6.1 below). In providing the case studies the group members accept responsibility to provide further information, regarding what was actually undertaken with the study, how this has been taken forward since completion, and how similar methods can be used elsewhere.

It should be stressed that they are not presented as best practice examples in implementing the pressures and impacts analysis required by WFD. This is for two reasons. Firstly few, if any, pressures and impacts analysis have been undertaken in response to the WFD. The case studies are therefore based on previous analyses that conform, at least in part, to WFD requirements but without being driven by them. Secondly, the examples have not been assessed by IMPRESS as meeting the WFD criteria. They are intended to reflect what is done within the Member States, and to facilitate contact between users of the Guidance working in similar technical, operational or geographical areas.

It is hoped that the examples presented here are the seed for a living document that is supplemented by examples of the actual analyses required by the WFD. Thus with time, the content should move from reflecting current practice, to present case studies that truly represent best practice, and which can be considered exemplary in all aspects.

urrent practice contained in Annex V.

	Link to guidance	**Techniques used**	**Link to tools**	**Case study**	**Transfer -ability**	**Water body**
ising ongoing rective 76/464/EEC[1] s – DSD)	Relevant pollutions identification					
	Pollution Pressure quantification tool (4.3)	GIS Coefficient models	✓ SENTWA ✓ SIMCAT × Belgian Biotic Index/Prati Index	No	Yes	Surface
ry	Pressure quantification tool (4.3)	Coefficient models	No	Yes	Yes	Surface
	Water use pressure	GIS Water balance	No	Yes	Yes	
Guadiana	Quantification of pollution pressures	GIS Hydrological model		Yes	Yes	River
	Lowering groundwater table	2 & 3D models	No	No	Yes	Ground- water
nulator for optimising ana	Flow regulation, hydro-morphological pressures	Various models	× ENMAG HEC-RAS × QUAL2E × RICE × HABITAT	Yes	Yes	River
ns in the river water	Flow regulation	Modelling	No	Yes	Yes	
erations related to	Hydromorphology		No	Yes	Yes	Transitional & coastal
sing EuroWaternet	Diffuse pressures	Statistical analysis	No	Yes	Yes	
d likelihood of meeting ccounts methodology.	Pressure screening	Thresholds	LAWA screening tool	No	No	River
ejo	Impact modelling	Modelling	(QUAL2E model)	Yes	Yes	River
ification pressures and urpose of reporting to	Pressure screening tool and impact assessment tool	Thresholds	LAWA screening tool	No	Yes	Surface
Basin Management	Pressure quantification, hydromorphological pressures	Statistical analysis	Models	Yes	Partly	Surface, Ground-water
ment of a River Basin	Pressure and impact assessment	Thresholds, Modelling	LAWA screening tool	Yes	Partly	Surface

used by certain dangerous substances discharged into the aquatic environment of the Community (OJ L 129, 18/05/1976, p. 23).

7. Concluding remarks

In its fourth official meeting (Lisbon 10/11 Sept 2002) the IMPRESS group discussed outstanding issues, issues not agreed and further work required. This Chapter summarises the results of this discussion.

Outstanding Issues: None

Further work required:

Short term actions (2002-3):
Threshold pressure screening criteria: Investigate whether threshold criteria should be developed by individual Member States to allow the pressures and impacts analysis to progress consistently across Europe.

Workshops on pressure and impacts analyses: Practitioners would benefit from opportunities to exchange expertise and experience gained as the first pressures and impacts analyses are undertaken. This should continue into the mid term with a second workshop once the initial assessments have been made and reported.

Template for reporting: Consistent reporting would be achieved by developing a template for reporting requirements.

Readability: It is appreciated by the IMPRESS group that the Guidance Document would benefit from an edit to improve readability. Such an edit should not change the content of the guidance.

Mid term actions (2004-5):
Maintenance of IMPRESS Case Studies Information System: The case studies included in the Guidance should be maintained as a reference source for practitioners. A particular benefit of this would be that new case studies could reflect *best practice* in implementing the directive, whereas those included at present reflect current practice that is in accordance with requirements of the directive.

Identification of other tools: There will be an on-going requirement to identify and co-ordinate tools for use within the pressures and impacts analysis.

Links to programme of measures, reference conditions and monitoring requirements: These are all important links that must function correctly for successful implementation of the Directive as a whole, but have been addressed within separate CIS working groups. These is also a need to identify measures that best address pressures and impacts to give cost effective mitigation of impacts to restore ecology.

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ANNEX I COMMON IMPLEMENTATION STRATEGY AND ITS WORKING GROUPS

CIS Working Group: Analysis of pressures and impacts; Lead: UK, Germany

CIS Working Group: Reference conditions inland surface waters; Lead: Sweden

CIS WORKING GROUP: TYPOLOGY, CLASSIFICATION OF TRANSITIONAL, COASTAL WATERS; Lead: UK, Spain, EEA

CIS Working Group: Heavily Modified Water Bodies; Lead: Germany, UK

CIS Working Group: Geographical Information Systems; Lead: JRC Ispra

CIS Working Group: Intercalibration; Lead: JRC Ispra

CIS Working Group: Monitoring; Lead: Italy, EEA

CIS Working Group: Economic analysis; Lead: France, Commission

CIS Working Group: Tools on assessment, classification of Groundwater; Lead: Austria

CIS Working Group: Best practice in river basin planning; Lead: Spain;

ANNEX II GLOSSARY

Term	Definition
Abstraction	The deliberate removal of water from a water body, either surface or groundwater.
Artificial recharge	The deliberate introduction by man of water into the subsurface
Baseline scenario	Projection of the development of a chosen set of factors in the absence of policy interventions.
Diffuse Source Pollution[2]	Pollution which originates from various activities, and which cannot be traced to a single source and originates from a spatially extensive land use (e.g. agriculture, settlements, transport, industry). Examples for diffuse source pollution are atmospheric deposition, run-off from agriculture, erosion, drainage and groundwater flow.
DPSIR	The Driver, Pressure, State, Impact and Response framework for environmental analysis
Driver	An anthropogenic activity that may have an environmental effect (e.g. agriculture, industry), also driving force
flux	A transfer of a substances through a medium
Hydromorphology	The physical characteristics of the shape, the boundaries and the content of a water body. The hydromorphological quality elements for classification of ecological status are listed in Annex V.1.1 and are further defined in Annex V.1.2 of the Water Framework Directive.
Impact	The environmental effect of a pressure (e.g. fish killed, ecosystem modified).
load	The transfer of material, dissolved or particulate, associated with a flow of water
Point source pollution	Pollution arising from a discrete source , e.g. the discharge from a sewage treatment works
Pressure[3]	The direct effect of the driver (for example, an effect that causes a change in flow or a change in the water chemistry of surface and groundwater bodies.
Response	The measures taken to improve the state of the water body (e.g. restricting abstraction, limiting point source discharges, developing best practice Guidance for agriculture).
Significant pressure	In the context of the WFD, a pressure that, on its own, or in combination with other pressures, would be liable to cause a failure to achieve the environmental objectives set out under Article 4.
State	The condition of the water body resulting from both natural and anthropogenic factors (i.e. physical, chemical and biological characteristics)
Status	The physical, chemical, biological, or ecological behaviour of a water body

[2] Interim working definition. Discussions in the context of the WFD implementation are ongoing.
[3] Interim working definition. Discussions in the context of the WFD implementation are ongoing

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ANNEX IV PRESENTATION OF EXAMPLES FOR TOOLS (ANNEX TO CHAPTER 4)

0. Overview

The annex contains a list of tools mentioned in the main text, indicating their scope and some summaries of the tools themselves.

The tools may be presented in this annex, reported in Chapter 6 (Examples of current practice) or have been mentioned without summary. This is indicated in the table below. This table indicates the scope of the tool and which water body category it covers. The tools presented in this annex follow the order of the table.

Table Annex V.1: list, scope and location of summaries related to tools

Tool name	Location	Tool scope			Water body category			
		screening	Pressure & impact	State assessment	R	L	GW	C
1) Pressure Screening and Assessment Tools								
Pressure Checklist	Chapter 4	X			X	X	X	X
HMWB	This Annex	X	Morphology		x			
EuroWaternet	Best Practices Examples	X		X	x	(x)	(x)	
LAWA Pressure Screening Tool	Chapter 4	X			X			
Water Quality Accounts	Best Practices Examples	X		X	x			
OECD (lakes)	*Not Quoted*	X	Impact			X		
2) Tools for Quantification of Pollution Pressures								
OSPAR	This Annex		Pollution		x			x
MONERIS	This Annex		Pollution		x		x	x
SENTWA	This Annex		Pollution		x		x	
Nopolu	This Annex		Pollution	X	x	X	x	x
3) Tools to Combine Pressures with Impact Assessment - Water Body Models								
SIMCAT	This Annex		Impact		x			
Groundwater models	See Chapter 4		Pollution, Transport					
4) Impact Assessment Tools								
Finnish assessment tool	This Annex			X	x	x		
England & Wales	This Annex			X	x			
LAWA assessment tool	This Annex			X	x			
French SEQ-"water body category"	This Annex			X	x	x	x	x

Before using any tool you must be sure that it is fit for the purpose for which you want to use it. You should have a clear objective defined, i.e. what questions you want to answer, and should select a tool that is capable of simulating the pressure and impact being considered and of providing the required results. You should be aware of the capabilities and limitations of each tool.

In the next Sections example tools or models are described, but it is necessary to stress that most of the tools described are currently used within member states for functions similar, or possibly identical, to those required by the WFD, and in general such usage was mandatory for a tool to be included. Many more tools exist, and no doubt will become available in the future.

Pressure assessment tools are applicable for most elements of the environment and are used to perform two principal functions. The first is to enable a preliminary assessment of whether a potential impact is worth considering further within the pressure and impacts analysis. It is likely that any such an assessment will be reviewed later in the analysis, particularly if observed impacts cannot be attributed wholly to those pressures initially deemed worth considering.

The second function is only applicable in rare situations in which no other information exists. In such cases, pressure assessment may be the only means to assess the risk of failing objectives. Such an assessment would be subject to review in the light of the data monitoring programme required by the WFD. This is most likely to be the case for groundwater bodies because of the time lag before pressures are manifested as observable impacts in the environment.

Care must be taken in the use of such pressure screening tools, since they cannot properly account for the vulnerability of different water bodies that result both through issues related to scale and the characteristics of the water body's catchment area.

1. Pressure Screening and Assessment Tools

Note: Most of the pressure tools are already described in other Sections of this Guidance due to their importance for the general approach and the practicability needs of the first characterization.

- **HMWB pressure identification tool**

The HMWB Guidance offers some tools to identify hydromorphological pressures and impacts. In Table Annex IV.2 main uses and the connected physical alterations are given.

Table Annex IV.2: Overview of main specified uses, physical alterations and impacts on hydromorphology and biology

Specified Uses	Navi-gation	Flood protection	Hydro-power generation	Agri-culture/ Forestry/ Fishfarms	Water-supply	Recreation	Urbani-sation
Physical Alterations (pressures)							
Dams & weirs	X	X	X	X	X	X	
Channel maintenance/dredging/removing of material	X		X	X		X	
Shipping channels	X						
Channelisation/straightening	X	X	X	X	X		X
Bank reinforcement/fixation/ embankments	X	X	X		X		X
Land drainage				X			X
Land claim				X			X
Creation of back waters through embankments	X					X	X
Impacts on hydromorphology and biology							
Disruption in river continuum & sediment transport	X	X	X	X	X	X	
Change in river profile	X	X	X	X			X
Detachment of ox-bow lakes/wetlands	X	X	X	X	X		X
Restriction/Loss of flood plains		X	X				X
Low/reduced flows			X	X	X		
Direct mechanical damage to fauna/flora	X		X			X	
Artificial discharge regime		X	X	X	X		
Change in groundwater level			X	X			X
Soil erosion/silting	X		X	X			X

2. Tools for Quantification of Pollution Pressures

- OSPAR Harmonised Quantification and Reporting Procedures for Nutrients and Hazardous Substances (HARP-NUT and HARP-HAZ)

Methods of assessing, quantification and reporting sources of nitrogen, phosphorus and hazardous substances are agreed in OSPAR in the HARP-Process (Harmonised Quantification and Reporting Procedures).
For **Nutrients** the following guidelines are available:
1. HARP framework and approach;
2. Aquaculture;
3. Industry;
4. Sewage Treatment Works and Sewerage (including storm waters and their overflow);
5. Households Not Connected to Sewerage;
6. Diffuse Sources and Natural Background Losses;
7. Riverine Load;
8. Source Apportionment;
9. Retention in River Catchments.

Guideline 6: *Quantification and Reporting of Diffuse Anthropogenic Sources, and Background Losses* mentions the following diffuse nitrogen and phosphorus loss pathways to surface waters (see analogous Figure 4.1):
- Losses by surface runoff (transport of dissolved nitrogen and phosphorus);
- Losses by soil erosion (transport of particular, adsorbed nitrogen and phosphorus);
- Bank and riverbed erosion;
- Losses by artificial drainage flow (through drainage pipes/tile drainage);
- Losses by leaching (net mineralisation, percolating waters *i.e.* interflow, tile drain flow, spring water and groundwater); and
- Direct atmospheric deposition on inland surface waters.

This guideline describes principles behind the estimation of losses from both diffuse anthropogenic sources, and natural background losses. Appended to the Guideline are examples based on methods used in Switzerland and Germany, the UK, Denmark, the Netherlands and Ireland.

The **Hazardous Substances** Guidelines include:
1. Overall HARP-HAZ Guidance Document;
2. Brominated Flame Retardants;
3. Cadmium;
4. Dioxins;
5. Lead;
6. Lindane;
7. Mercury and Mercury Compounds;
8. Nonylphenols (NP) and Nonyphenolethoxylates (NPE) and Related Substances;
9. Polycyclic Aromatic Hydrocarbons (PAH);
10. Uncontrolled PCB-containing products.

These guidelines include information on the following groups of sources of the mentioned substances:
- Agriculture;
- Transport/Infrastructure;

- Building Materials;
- Households;
- Industry (IPPC);
- Industry (non-IPPC);
- Waste Disposal;
- Contaminated Land;
- Other direct diffuse sources.

It is worth noting that the HARP-NUT guideline 6 on diffuse sources of nutrients was the only one not fully agreed within the OSPAR framework. These, and other methods, are currently being assessed within the EUROHARP project (http://www.euroharp.org/index.htm). EUROHARP will compare nine different contemporary methodologies for quantifying diffuse losses of N and P, on a total of seventeen study catchments across gradients in European climate, soils, topography, hydrology and land use. The selected methodologies are applicable at catchment scale and are currently used by European research institutes to inform policy makers at national and international levels. A primary objective of EUROHARP is to provide end-users (national and international European environmental policy-makers) with a thorough scientific evaluation of the nine contemporary quantification tools and their ability to estimate diffuse nutrient (N, P) losses to surface freshwater systems and coastal waters; and thereby facilitate the implementation of the Water Framework Directive.

Prior to the completion of this review, users are advised to select the most appropriate methodology for their circumstances. This requires some assessment of the inputs of N and P to the soil, and understanding of the processes and pathways through which they are lost from the soil. Since N and P losses can vary substantially, land cover and land use data are essential for the analysis, possible sources of these are the European-wide co-ordinated data-sets CORINE Land cover (Co-ordination of Information on the Environment) and NUTS (Nomenclature for Statistical Territorial Units). Data on atmospheric deposition may be obtained from EMEP (Co-operative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air pollutants in Europe).

The methods generally use export coefficients that are related to one or more of the following: crop type, stocking density, soil type, climate, eco-region and slope.

Reference

OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic, *Harmonised Quantification and Reporting Guidelines*

For Nutrients: Norwegian Pollution Control Authority (sft) 1759/2000 (ISBN 82-7655-401-6) http://www.ospar.org/eng/html/welcome.html (Measures -> Agreements -> List of Agreements (2000);

For Hazardous Substances: sft 1789/2001 (ISBN 82-7655-416-4) http://www.sft.no/english/harphaz/

- MONERIS

Germany used the model MONERIS (Modelling Nutrient Emissions in River Systems) for the estimation of the nutrient inputs into river basins of the German Baltic Sea catchment area by various diffuse pathways. The model is based on a geographical information system (GIS), which includes digital maps as well as extensive statistical information and monitoring data in rivers, groundwater, drainage and point source effluents. A detailed description of the German Emission method including all of the pathways is contained in the report "Nutrient Emissions into River Basins of Germany", which was published in UBA Texte 23/00 in 2000.

Whereas waste water treatment plants and industrial sources are directly discharged into the rivers, diffuse emissions into surface waters are caused by the sum of different pathways, which are realised by separate flow components (see Figure Annex IV.1). This separation of the components of diffuse sources is necessary, because nutrient concentrations and relevant processes for the pathways are mostly very different. Consequently six diffuse pathways are considered in the model, for which the losses were determined separately:

- atmospheric deposition;
- erosion;
- surface runoff;
- groundwater;
- tile drainage;
- paved urban areas.

Along the pathway from the source of the emission into the river substances are governed by manifold processes of transformation, retention and loss. Knowledge of these processes of transformation and retention is necessary to quantify and to predict nutrient discharges/losses into the rivers in relation to their sources. Since current knowledge of the processes and the up to now limited database especially for river basins of medium and large size, the description of the processes can not be done by detailed dynamic models.

Therefore, MONERIS estimates the different pathways with already existing and new conceptual approaches, which are developed especially for the modelling in the medium and large spatial scale. Topics of the model development were:

- to develop a GIS-supported method for regional differentiated estimation of discharges/losses from point and diffuse sources for river basins of a size of more than 500 km²;
- to establish a sub-model for regionally differentiated estimation of nutrient discharges from waste water treatment plants and industries by a countrywide detailed inventory of these waste water treatment plants and industries;
- to establish a sub-model for inputs of nutrients and suspended solids caused by erosion, which can be applied to all investigated river basins. This model is based on the modified uniform soil loss equation but considers only those areas, which are relevant for input into the river system. The sub-model was validated with observed loads of suspended solids and particulate phosphorus for river basins;
- to develop a sub-model which allows the estimation of groundwater concentrations of nitrogen from the nitrogen surplus in agricultural areas by means of a retention function. This retention function is dependent on the hydrogeological conditions, the rate of groundwater recharge and the nitrogen surplus itself. The retention model includes first raw estimates of the residence time of water within the unsaturated zone and aquifer of the river basins;
- to develop a GIS-supported sub-model for regionally differentiated estimation of the agricultural areas modified by tile drainage. The sub-model is based on soil types and a classification of soil water conditions and is validated by overlaying digitised maps of tile drained areas with a soil map;
- to establish a sub-model for different pathways of nutrient discharges/losses within urban areas considering the regional differences in the sewer systems and the development of storage volume especially for combined sewer systems; and
- to establish a sub-model for nutrient retention and losses in surface waters, which can be applied for all river basins. This model is based on the dependency of the nutrient

retention on the hydraulic load or the specific runoff in the river system. The model allows the estimation of the nutrient loads from the nutrient inputs in a river basin. Therefore, a direct comparison of calculated and observed nutrient loads is possible for river basins upstream of a monitoring station.

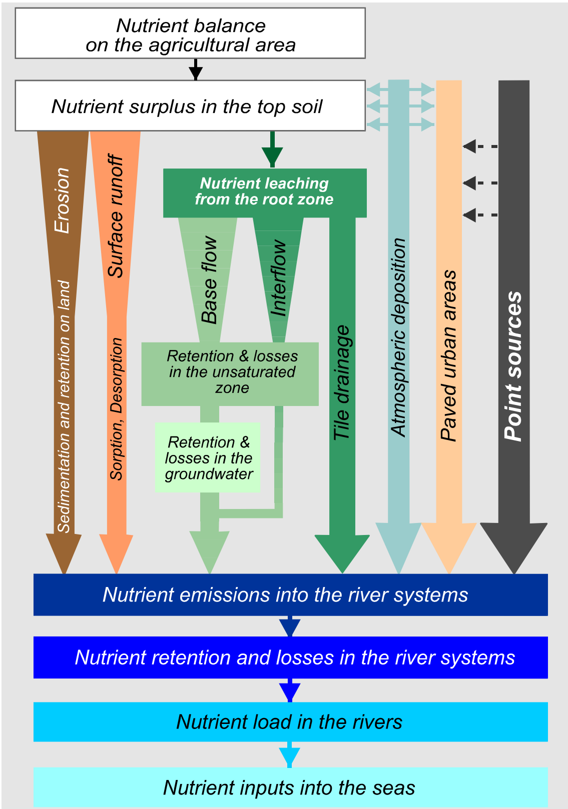

Figure Annex IV.1 Pathways and processes within MONERIS.

One special topic of the model development was that the different sub-models were be validated by using independent data sets, for example the groundwater model was developed with the observed nitrogen concentrations in the groundwater and not on the basis of the observed nutrient loads in the rivers.

The use of a GIS allows a regional differentiated quantification of nutrient discharges/losses into river systems. Therefore, estimates were not only carried out for large river basins. The MONERIS model was applied to 300 German river basins with a size between 100 and 5000 km² for the time period 1985, 1995 and 2000.

- <u>SENTWA (System for the evaluation of the nutrient transport to surface water)</u>

The SENTWA model 'System for the evaluation of the nutrient transport to surface water' is a model to simulate the nutrient emissions from agriculture (manuring) to the surface water. This model is formulated by the CODA (Centre for research in veterinary medicine and agrochemicals) from the Federal Ministry of Agriculture in 1993 on the basis of a German pilot study in the Elbe region. The CODA has adjusted the model for Belgium and has refined the model by validation and calibration of the model for the Regions 'Zwalm' (sandy loam) and 'Mark' (sandy) in Flanders (Belgium) (in 1997) by order of the Flemish Environment Agency (VMM).

It is a semi-empirical model that quantifies orders of magnitudes of the nutrient emissions from agriculture. It quantifies the load total N and total P (kg or ton N/P; kg or ton N/P per ha) on an annual or monthly basis and per river catchment. There are 11 river catchments in Flanders.

The model is designed as a tool for supporting and evaluation of the policy of agriculture/environment.

The model consists of 7 routes of emissions:

- Atmospheric losses;
- Direct losses :
  - direct losses by use of fertilizer (chemical manure);
  - direct losses by grazing of animals (organic manure);
  - direct losses by stabling animals (organic manure);
  - direct losses by saps of manure or silo's;
- Drainage losses (these are the losses at normal agricultural manuring);
- Ground water losses (these are the losses at normal agricultural manuring);
- Excess losses (these are the losses at excessive manuring);
- Erosion losses;
- Run off losses.

First, these losses are calculated on an annual basis (on the scale of the municipality) and then they are divided among the months taking into account different factors such as precipitation, use of fertilizer, agricultural practice, etc.

Which input is demanded?

Data of agricultural land use and of different kind of animals (cattle);
Data on excretion coefficients for the different kind of animals (cattle);
Data of use of fertiliser;
Data on transport of manure;
Data on precipitation;
Data on the yields of different crops;
Data on manuring standards;

These input factors are available on the scale of municipality, or provinces, or agricultural region developments:

- In 1999-2000 the model was rewritten in a more user-friendly way and in another programme language (DELPHI instead of DBASE) as instructed by VMM;
- In 2000-2001 ERM was commissioned by VMM to study the different parameters, factors, coefficients used in SENTWA in order to ameliorate the model if possible and useful;
- In the summer of 2002, the new calculations with the ameliorated model were carried out.;
- In the autumn of 2002, a refinement of the model for drainage losses, ground water losses and excess losses will be wound up. The calibration will be done for the agricultural region of the polder lands;
- NOPOLU System (for example used to check in France EEA/ETC-W) emissions assessment methodology.

Since 1993, Ifen (French national focal point of EEA) uses the NOPOLU system to handle data related to catchments and produce relevant data.

The system is based on full (although progressively implemented) description of the hydrologic and administrative features of metropolitan France. The catchments are analysed through 6210 polygons (aggregated up to 6 water agencies / 55 main catchments) and the administrative layers are analysed through more than 36,000 municipalities. The relationships between both definitions is managed by the system, by the way of specific links (big cities discharging in a far away river) or by crossing tables derived from CORINE *land cover*.

Data currently managed are river discharge, river monitoring data, rainfall (including efficient rainfall), water abstractions, industrial activities (including production, emission data, waste water treatment plants), urban activities (population, WWTP functioning, sewerage, including industries connected).

The main characteristic is that the system is highly integrated in order to facilitate cross comparison of results, with the objective to fulfil OSPAR guidelines as well as conforming with Directives. A second important feature is that:

- The system seeks individual data related to an item (e.g. WWTP running data), and if these are lacking it replaces them with standard values that can be highly regionalised. This is to prevent bias quantification, hence it is not totally "data provision dependent";
- Single system of GIS management is in use: the same data is used on the same areas to compute Water quality accounts, EuroWaternet representative networks as well as agricultural surplus, industrial emissions or riverine fluxes.

With regard to quantification of pressures, the main outputs are the quantification of pollution discharges (urban, industrial, agricultural), direct and diffuse that was set up and checked over by the Loire-Bretagne water agency in 1999.

The outputs can be provided at any scale and modality. For example, industrial emissions can be produced under the NACE (information is available under the http://nace.org/nace/content/AboutNace/aboutnaceindex.aspnomenclature site) by NUTS3, and disaggregated as direct discharge, through industrial treatment facility or via urban sewers. They can also be summed at any point of the catchments, to compare with the riverine fluxes, also calculated in NOPOLU, by processing river discharge and river chemical data.

The structure of the system is oriented to full transparency and disprovability, thanks to intermediate results. Hence, the agricultural pollution module firstly calculates the surplus that can be compared with independent data, and then the transfer, which is reconciled with urban and industrial discharges and riverine fluxes.

NOPOLU is constructed around Access 2000 (open to Oracle client/server) databases, most procedures are in Visual Basic, and it can process any external module (including APL). It is maintained by Beture-Cerec, subsidiary of JAAKKO PÖYRY.

3. Tools to Combine Pressures with Impact Assessment - Water Body Models

The tools described in the other Sections of this Annex enable some assessment of the likely significance of the pressure being considered, either by directly inferring that the water body is at risk of failing to meet its objectives, or by highlighting that the pressure requires further investigation.

Often the output from these tools must be combined with another tool that combines the information on pressures with a representation of the receiving water body. Thus, for example, the pressure resulting from an abstraction is first quantified, and then combined with information on a river system to determine the actual impact.

A great many models exist that may be useful in undertaking the pressures and impacts analysis required by the WFD. This Guidance cannot provide a comprehensive catalogue of these models, or recommend particular models. The following Sections are intended to inform the reader of the various types of model that exist, and that may be useful in a particular situation.

The models are often based on domains (i.e. characteristic areas), and most cases the domain relates to a water body type (e.g. river, lake, coastal water). These individual domain models can be linked together in various ways to represent a larger system, for example, a diffuse model (perhaps a pressure quantification tool described in Section 4.30) may be linked to river models and groundwater models to represent the whole hydrological system within a catchment area. Other models represent many domains within a single framework.

Many current projects at both national and European scale have the objective of providing detailed information on modelling techniques in support of the WFD. One prominent is BMW (Benchmarking Models for the WFD, http://www.vyh.fi/eng/research/euproj/bmw/homepage.htm). While, these project are unlikely to report until after the initial impact assessment should be completed, they may provide information on useful modelling techniques.

- **Hybrid Monte-Carlo deterministic model for rivers - SIMCAT**

This type of modeling tool places a deterministic description of transportation and in-stream processes within a Monte-Carlo framework. A large number of independent model runs are used to generate distributions of the water quality within the river network. To achieve this, the model requires all inputs (tributaries, discharges and abstractions) to be specified as either constant, normal, log-normal, 3-parameter shifted log-normal, or non-parametric distributions, on either an annual or monthly basis. Each model run samples of these distributions, either randomly, or using user-defined correlations between flow and quality, between discharge flow and flow in the receiving river, or between flow in tributaries and flow in the main river. From the derived distributions SIMCAT abstracts the mean and 95%ile or 90%ile for each determinand. Confidence limits are also provided.

SIMCAT does not solve the advection-dispersion equations, using instead a simple load addition formula at each reach to calculate concentration, and a flow-velocity relationship to calculate movement downstream. Pollutants are assumed to be instantly and uniformly mixed in the receiving water and to travel at the same velocity as the water in the receiving reach.

The model includes chloride, BOD, ammonia and DO as standard determinands. Chemical processes included are re-aeration, the decay of BOD, and nitrification of ammonia (based on a modified Streeter-Phelps equation) Processes are represented by first order decay with temperature sensitivity. All decay and re-aeration parameters, and velocity relationships can be specified separately for each reach.

Calibration can be either manual or using the model's internal calibration routine, which adjusts the fit of the model's output to measured data by adjusting parameters and diffuse flow. In auto-calibration mode, SIMCAT feeds in extra river flows so that the results match those at flow gauges, as a function of river length, and calculates a series of adjustments to quality parameters to match model quality distributions with those at monitoring stations.

The sequence of auto-calibration is that model results are first compared with data at a monitoring station. A set of adjustments to parameters and velocity which would allow exact agreement with measured data is calculated, and the model then goes back to the upstream monitoring station quality data and repeats its downstream calculations, using the new values for parameters, flow and velocity. The new model results are compared with the monitoring station data, and the process repeated, if necessary.

- ***Existing use***

SIMCAT is a model which has been developed in-house for the Environment Agency (England and Wales) and is widely used in water quality planning. Once a model is calibrated, it may be used by less experienced staff, as the model run method and output are simple and clear. A catchment model should, however, always be calibrated by competent technical staff, and carefully checked, as errors in the interpretation of input data, can, in this type of model where calibration is based solely on input data, lead to an erroneous calibration and thus misinterpretation of results.

- ***Relevance to pressures and impacts analysis***

This type of tool is primarily intended for investigation of impacts on general chemical quality of rivers from point sources of pollution. It enables the impact of the pressure from each source to be assessed individually and in combination. The diffuse loading can also be derived.

- ***Reference and Documentation***

The model manual provides a step by step guidance through the model set-up process. There is a Section on the model's statistical background which is comprehensive. The manual also gives the form of all the decay parameters used in the model, the time of travel equations and the methods of assessing confidence limits.

4. Impact Assessment Tools

- **Finland national classification of water quality**

The present Finnish water quality classification system has been developed in order to give information on water usability for human purposes, taking into account only those ecological quality elements, which have a direct impact on water usability. It treats all water bodies similarly, not making any difference between different water categories or water body types. Classification is mostly based on chemical quality elements, but also some biological elements (hygienic indicators, chlorophyll and algal blooms). Criteria and threshold concentrations can be found in Table Annex IVb.3.

Table Annex IV.3 : The Finnish national classification system.

Class	Class interpretation	Variables and their threshold values
I excellent	The watercourse is in natural condition, usually oligotrophic, clear or with some humus. Highly suitable for all modes of uses.	colour < 50 mg Pt/l transparency > 2.5 m turbidity < 1.5 FTU faecal coliforms or faecal streptococci < 10 CFU/100 ml total phosphorus < 12 µg/l mean chlorophyll-α in the growing season < 3 µg/l
II good	The watercourse is in near-natural condition or slightly eutrophic. Water is still suitable for most modes of uses.	oxygen concentration in epilimnion 80-100%, no oxygen deficiency in hypolimnion colour 50-100 mg Pt/l (< 200 in natural humic waters) transparency 1-2.5 m faecal indicator bacteria < 50 CFU/100 ml total phosphorus < 30 µg/l mean chlorophyll-α in the growing season < 10 µg/l
III satisfactory	The watercourse is slightly affected by wastewaters, non-point loading or other changing activity, or is appreciably eutrophic due to natural causes. The watercourse is usually satisfactory for most modes of uses.	oxygen concentration in epilimnion 70-120%, some oxygen deficiency may occur in the hypolimnion colour < 150 mg Pt/l faecal indicator bacteria < 100 CFU/100 ml total phosphorus < 50 µg/l mean chlorophyll-α in the growing season < 20 µg/l
IV fair	The watercourse is strongly affected by wastewaters, non-point loading or some other changing activity. Water is suitable only for modes of use having few water quality requirements.	oxygen concentration in epilimnion 40-150%, oxygen deficiency in the hypolimnion faecal indicator bacteria < 1000 CFU/100 ml total phosphorus 50-100 µg/l mean chlorophyll-α in the growing season 20-50 µg/l algal blooms common concentrations of elements representing a health hazard: As < 50 µg/l, Hg < 2 µg/l, Cd < 5 µg/l, Cr < 50 µg/l, Pb < 50 µg/l total cyanide < 50 µg/l off-flavours often found in fish
V bad	The watercourse is extensively polluted by wastewaters, non-point loading or other changing activity Poorly suited to any form of watercourse use.	major problems of oxygen balance, oxygen saturation in the epilimnion during summer may exceed 150%; on the other hand total oxygen depletion at the surface may occur; at the end of the stratification season the whole hypolimnion may be anaerobic faecal indicator bacteria > 1000 CFU/100 ml total phosphorus > 100 µg/l mean chlorophyll-α in the growing season > 50 µg/l one or more of the following exceeds the threshold limit specific for class IV: As, Hg, Cd, Cr, Pb or total cyanide mercury concentration in predatory fish species >1 mg/kg oil film on the water surface often observed

- **Environment Agency (England and Wales) River Ecosystem Classification**

The England and Wales River Ecosystem Classification scheme is presented in Table Annex IV.4. The physico-chemical quantities used can be obtained from observed data or modelled output. Classes 1 and 2 are considered represent conditions suitable for salmonid and cyprinid fish populations.

Table Annex IV.4:The river ecosystem classification used by the Environment Agency of England and Wales

Class	Dissolved oxygen % saturation 10th %ile	BOD mg l^{-1} 90th %ile	Total ammonia mg N l^{-1} 90th %ile	Un-ionised ammonia mg N l^{-1} 95th %ile	pH lower limit 5th %ile to upper limit 95th %ile	Hardness mg l^{-1} $CaCO_3$	Dissolved copper µg l^{-1} 95th %ile	Total zinc µg l^{-1} 95th %ile
1	80	2.5	0.25	0.021	6.0-9.0	≤ 10 >10, ≤ 50 > 50, ≤ 100 > 100	5 22 40 112	30 200 300 500
2	70	4.0	0.6	0.021	6.0-9.0	≤ 10 >10, ≤ 50 >50, ≤ 100 > 100	5 22 40 112	30 200 300 500
3	60	6.0	1.3	0.021	6.0-9.0	≤ 10 >10, ≤ 50 >50, ≤ 100 > 100	5 22 40 112	30 200 300 500
4	50	8.0	2.5		6.0-9.0	≤ 10 >10, ≤ 50 >50, ≤ 100 > 100	5 22 40 112	30 200 300 500
5	20	15.0	9.0					

- **German impact assessment tool (LAWA)**

Data on the state of a water body available from environmental surveillance should be examined. Primarily data on the state of a water body will be considered to evaluate the impacts of the pressures and will be judged according to quality objectives and aggregation criteria. If these are insufficient, an assessment or consideration of a model based on established pressures is necessary. An estimation of probability that the good ecological or chemical conditions will not be achieved within a period of observation will be made on the basis of the criteria presented in Table Annex IV.5.

Table Annex IV.5: Information necessary for the assessment of impacts (LAWA)

Indicator	Threshold values
Saprobic status	> 30% of stream network > national biological quality level (here: biological quality level II)
Trophic status	> 30% of stream network > national quality level (here: trophic class > II, assessment basing on concentrations of Nitrate-N > 6 mg/l and Phosphate-P > 0,2 mg/l; 50-percentile
Physicochemical substances	Exceeding existing quality objectives or quality criteria of EU directive 76/464/EEC and knowledge about entries of priority substances
Warming	According to the EU Fish-Life Directive: - max. annual temperature: >21.5°C (salmonid water body) >28°C (cyprinid water body) - max. winter temperature: >10°C (salmonid water body) >10°C (cyprinid water body) - max. warming up: 1.5 K (salmonid water body) 3.0 K (cyprinid water body)
Salinisation	Median: CI =400 mg/l

Indicator	Threshold values
Morphology	• River habitat survey -- overview method: More than 30% of the river distances within the management unit are surveyed with structural quality classes 6 or 7 for the compartment "river bed (consisting of the parameters: – curvature – bank fixation – anthropogenic barriers – water flow regulation – bank vegetation • Impairment of river continuity (anthropogenic barriers, backwater) >30% of stream network

- **French SEQ based quality assessment approach**

The French approach is based on three major concepts, all consistent with EEA and Eurostat recommendations. These concepts are:

- a water quality assessment scheme (SEQ system) encompassing water, biology and physical media. It applies to running, still, transitional and groundwater;
- a procedure to produce water quality statistics, implemented after the EEA EuroWaternet full recommendations and a procedure to produce water quality accounts, implemented after Eurostat/UNECE general methodology.

The SEQ system proper provides quality assessment for each monitoring point from observed data. It comprises three working tools:

1. System for evaluation of the quality of water (SEQ-Water) which assesses water physico-chemical quality and which has been used in France since 1999;
2. SEQ-Bio that assesses the biological quality of the stream;
3. SEQ-Physical that assesses the artificialization level of the stream.

The basic principle backing the SEQ approach is that the different uses or functions of any water body must be assessed through determinants of the same kind or through having the same effect. For example, to assess the stream water quality, SEQ-Water distinguishes 15 descriptors (“altérations”), each one of them grouping relevant determinants. The assessment is carried out using threshold tables (see Table Annex IV.6 for an example) that define class limits. The index is calculated through an algebraic function adjusted to the threshold values.

SEQ-system then calculates the indexes (scale 0-100) for the potential ability of water to biology, (which are closely connected to the physico-chemical component of the ecological status described by the directive), and the indexes of the potential ability of water for use (such as drinking water, leisure and aquatic leisure, and so on, according to the needs).

The index can be presented in a second step as 5 classes. These classes are represented with the classical description of five colours (blue, green, yellow, orange, red). The classes represent the same degree of water body impact. Therefore, classes can be compared between descriptors and functions, thus allowing complex aggregation methods to be applied in a second stage.

Table Annex IV.6: Example of the SEQ assessment grid, descriptor "salinisation", use: drinking water, medium: groundwater (source: http://www.eaufrance.tm.fr/francais/etudes/pdf/etude80.pdf).

Altération Minéralisation et salinité

Paramètres	Unités	bleu clair	bleu foncé	jaune	rouge
Conductivité (1)	µS/cm à 20°c	≥ 180 et ≤ 400	> 400 et ≤ 2500	< 180 ou > 2500 et ≤ 4000	> 4000
Dureté	d°F	≥ 8 et ≤ 40		< 8 ou >40	
pH		≥ 6,5 et ≤ 8,5	> 8,5 et ≤ 9,0	< 6,5 et ≥ 5,5 ou > 9,0 et ≤ 9,5	< 5,5 ou > 9,5
Résidu sec (1)	mg/l	≥ 140 et ≤ 300	> 300 et ≤ 2000	< 140 ou > 2000 et ≤ 3000	> 3000
Chlorures (2)	mg/l	25	250		> 250
Sulfates (2)	mg/l	25	250		> 250
Calcium	mg/l	≥ 32 et ≤ 160		< 32 ou >160	
Fluorures	mg/l	≥ 0,7 et ≤ 1,5	< 0,7	> 1,5 et ≤ 10	> 10
Magnésium	mg/l	30	50	400	
Potassium	mg/l	10	12	70	
Sodium	mg/l	20	200		
TAC	d°F	≥ 8 et ≤ 40		< 8 ou >40	

(1) au moins l'un des deux paramètres doit être pris en compte.
(2) au moins l'un des deux paramètres doit être pris en compte.

The SEQ version 2 will soon be released, with a new computerised tool. It will include all 33 priority substances defined in annex X of the directive.

Full details are available in the PDF document that can be downloaded from http://www.eaufrance.tm.fr/ (downloading from the pages is only possible in French).

ANNEX V CASE STUDIES

A summary of the following case studies is contained in Chapter 6 of the main Guidance Document.

Title: **No: 1**

Selection of **specific pollutants** by using ongoing implementation work of Council Directive 76/464/EEC[4] (Discharge of Dangerous Substances – DSD)

Type of impact:

Increasing loads of chemicals, toxicity, ecotoxicity, accumulation and secondary poisoning

Type of pressure:

Point and diffuse sources of chemicals

Type of analysis or tool:

The Water Framework Directive requires the establishment of measures for against pollution in order to reach the objectives. On one hand, the priority substances (Annex X) are regulated in accordance to Article 16. On the other hand, other specific pollutants need to be identified on a river basin (district) scale (cf. Section 3.5 of the guidance).

Council Directive 76/464/EEC already provides for such a mechanism under Article 7 where Member States shall establish pollution reduction programmes for relevant pollutants of list II of that Directive. These so-called "list II substances" must also be selected out of a number of pollutant groups which are similar to the one in Annex VIII WFD.

It is recommended (and to some extent mandatory) to make best use of the implementation of this requirement of 76/464/EEC for the first analysis of pressures and impacts under the Water Framework Directive because, in particular:

- ✓ the transitional provisions (cf. Art. 22 (2) to (6)) require the implementation of 76/464/EEC is required as a minimum requirement and smooth transition must be ensured since the directive requirement will only be repealed in 2013;
- ✓ the rulings of the European Court of Justice which need to be respected;
- ✓ the experience and knowledge available in the Member States and Candidate Countries (which are currently identifying pollution reduction programmes as part of their accession commitment).

Further information on the relation of 76/464/EEC and WFD is available (see references).

Information and data requirements

Depending on the approach used, the following information will be needed, in particular:

- ✓ intrinsic properties (e.g. physico-chemical properties, persistence, (eco-)toxicity, bioaccumulation);
- ✓ emission inventories (e.g. European Pollutants Emission Register (EPER)[5], Article 11 of Directive 76/464);
- ✓ marketing and use data;

[4] Council Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (OJ L 129, 18/05/1976, p. 23).
[5] Commission Decision 2000/479/EC of 17 July 2000 (OJ L 192, p. 36).

- ✓ existing monitoring data (until 2006);
- ✓ surveillance, operational and investigative monitoring data (beyond 2006);
- ✓ Potential sources and emission routes;
- ✓ Fate and behaviour models;

Brief description including figures

The generic group of pollutants listed in Annex VIII cover a large number of individual substances. It is up to the Member States to establish an appropriate list of "**specific pollutants**" to be assessed for their relevance. However, the methodology for identifying **specific pollutants** is not specified in the Directive.

It is therefore recommended that the identification of **specific pollutants** under the Water Framework Directive should be further developed from the approaches used under Directive 76/464/EEC and the priority setting procedures elaborated for the selection of the priority substances.

It is evident that the 33 (group of) priority substances[6] and the eight list I substances[7] of 76/464/EEC which are not included in the Annex X WFD in the pressure and impact analysis since they will form the "chemical status".

For other **specific pollutants**, the starting point should be the substances identified as list II substances under Article 7 of 76/464/EEC. In addition, a candidate list of pollutants may be established which should be the starting point of a screening and priority setting process involving several steps.

Finally, the prioritisation process developed on European level, the so-called COMMPS[8] process, could be of additional use for the final selection of **specific pollutants** on a river basin scale. Moreover, the output of the Expert Advisory Forum on Priority Substances may also be useful for the pressure and impact analysis for other **specific pollutants**.

Based on the experiences of the implementation of the Directive 76/464/EEC, Member States have applied a wide range of approaches to identify "relevant list II substances".

However, it abstract terms, there are two generic approaches, which could be adopted for identifying potentially relevant pollutants:

- **Top-down approach** – this approach starts with the "universe of chemicals" and relies on all the available knowledge of the substances in order to screen for those substances which are of relevance in a river basin (district);

- **Bottom-up approach** – this focuses on those areas where existing monitoring data (biological and chemical) clearly identifies that the objectives may not be achieved. In addition, a specific, targeted and time-limited screening monitoring may complement the available information.

In most cases, a combination of both approaches is used by Member States.

References

[6] Decision 2455/2001/EC establishing the list of priority substances (OJ L 331, 15 November 2001, p. 1)
[7] The eight remaining list I substances are: drins (aldrin, dieldrin, endrin and isodrin), tetrachloroethylene (PER), trichloroethylene (TRI), Carbon tetrachloride, DDT
[8] Combined Modelling-based and Monitoring-based Priority Setting

"Study on the prioritisation of substances dangerous to the aquatic environment" Office for Official Publications of the European Communities, 1999 (ISBN 92-828-7981-X) [9]

Study report commissioned by the European Commission: "Assessment of programmes under Article 7 of Council Directive 76/464/EEC" (November 2001) [10]

Summary of Workshop on the "Discharge of Dangerous Substances Directive (76/464/EEC) - Lessons Learnt and Transition to the Water Framework Directive' of 1-2 July 2002 in Brussels (available through contact).

Furthermore, an ongoing study project of the European Commission on "Transitional provisions for Council Directive 76/464/EEC and related Directives to the Water Framework Directive 2000/60/EC" will produce specific outputs in relation to the above-mentioned aspects. Moreover, the Expert Advisory Forum on Priority Substances will produce several results which might be useful for the selection of other specific pollutants. These reports and the above-mentioned information is or will become available on the water web site of DG Environment:

www.europa.eu.int/comm/environment/water.

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[9] http://europa.eu.int/comm/environment/water/water-dangersub/pri_substances.htm
[10] http://europa.eu.int/comm/environment/water/water-dangersub/article7ofdirective77464eec.pdf

Title: **No: 2**

WATER QUALITY PLANS IN FLANDERS (Belgium)

Type of impact:

Status and change of water quality of surface waters.

Type of pressure:

Point and diffuse sources from households, industry and agriculture (and WWTP)

Type of analysis or tool:

Point source – households: number inhabitants x pollution factor (PE)
Point source – industry (only main companies): sampling results of discharges
Point source – agriculture:

- inhabitants is included in households;
- animals: inventories (number of animals x excretion factors).

Point source WWTP: sampling results of discharges
Diffuse source – households: number inhabitants x pollution factor x reduction factor
Diffuse source – agriculture: SENTWA-model (calculation of losses of nutrients)
Load reduction: GWQP-mass balance ; SIMCAT-model (WRc – water quality model)
Status of waterbodies: Biological (Belgian Biotic Index), Physical-chemical (Prati-index)

Information and data requirements

Basic information: map of catchment areas, PE-equivalents, EQS, list of industrial main polluters.

Variables: number of inhabitants, industrial and WWTP discharges, livestock inventories, manure transport, inventories of the actual and planned sanitation projects, water quality data, water flow, load and removal rates of WWTPs, production and removal of WWTP sludge, permitted industrial loads, costs of the sanitation projects.

Brief description including figures

With exception of the driving forces, the approach is an application for water quality of the DPSIR-framework. On catchment level, the pressures (discharges and inflows) and the effect of it on the quality of water bodies are assessed, considering point and diffuse source pollution from households, industry, agriculture and WWTP. The actual status and evolution for the last decade of the water quality of the water bodies is described.

At pressure (discharges and inflow) and status level a series of general physical and chemical pollutants (Q, BOD, COD, N, P, SM, O_2, etc.) (and in some cases also heavy metals) have been reported and loads have been calculated. For 3 parameters (COD, nitrogen, phosphorous) calculation of pollution loads result in 'load balances'. This makes it possible to calculate load reductions (at inflow and discharge level) in order to meet the environmental quality standards (EQS) (see Figure).

The policy instruments are described and result in a number of measures that can be used in a scenario or cost analysis (see Figure). A first attempt for scenario analyses has been made and a scenario has been defined for households, industry and agriculture. For that, measures have to be quantified. The result of this exercise reveals if the proposed measures are sufficient to reach the EQS in the future.

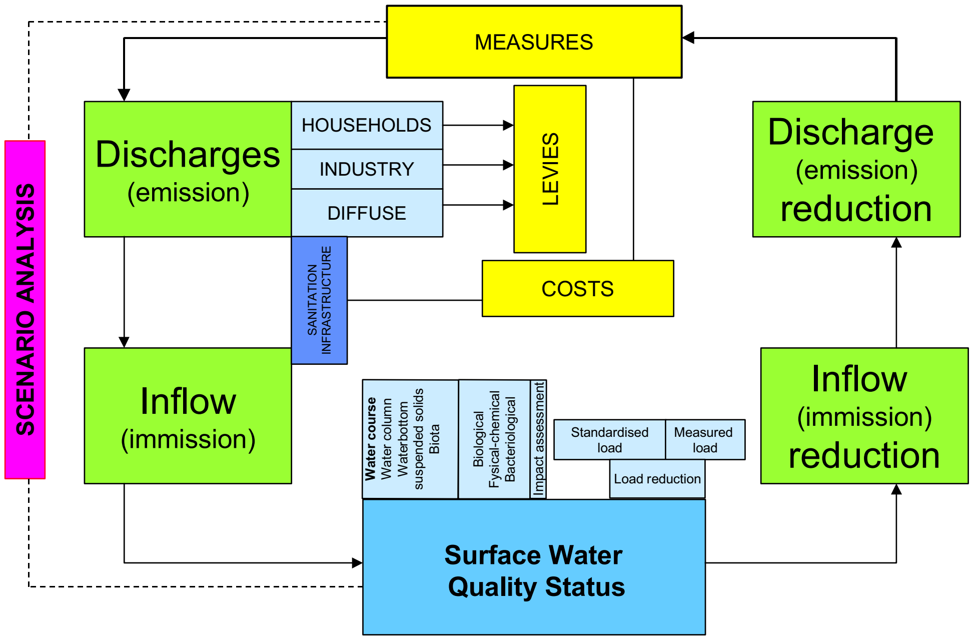
The outcome results in 2 types of reports. A summary report, in which the load balances (and in particular load reductions) are stressed, and an extended technical-scientific document, describing all aspects of water quality considered. This TS-document consists of a manual, describing the framework and all sources and tools used, and the report containing all basic information, results and conclusions. In annex a list of tables and figures is added.

This method is/will be applied to the approx. 260 stream catchments (hydrographical zones) within the 11 distinct river catchments of Flanders. The data collated in 34 tables provides information in a comprehensive way on sampling/monitoring of waste water and water quality, loads and load reductions, as well as a description of the catchments, the functioning of the WWTP-infrastructure, the water uses, etc. in relation to the target groups.

Important and useful are in particular:

- the framework, relating all aspects of water quality (see Figure as a flowchart). This framework is dynamic as it allows expansion with new topics e.g. analyses of cost-effectiveness;
- the use of pressure indicators (ratios) which enables results to be compared – on the one hand - from the pollution sources on the level of discharges, inflow and after sanitation measures have been completed, and – on the other hand – between the pollution sources (households, industry and agriculture), regardless the surface area covered;
- the availability of information on catchment level, to be summed on any other higher hydrographic level (e.g. river basin);
- the calculation of load reductions (see Figure: inflow reduction), tested against different EQS. Hydrographical zones may be ranked according to the reduction priorities tested against several legal or ecological EQS of COD, N and P. *Example: tested against an EQS of 0.3 mg/l P, load reduction within the river Nete basin must reach 85% or 1.924 kg/d; the contribution of the households to this is about 25% or 481 kg/d; the reduction is specifically high (> 75%) in 10 hydrographical zones.*

<u>Abbreviations:</u> COD: Chemical Oxygen Demand, EQS: Environment Quality Standard, GWQP: (General) Water Quality Plan, N: nitrogen, P: phosphorous, PE: population equivalent, WWTP: waste water treatment plant.



References

VMM, 2001. General Water Quality Plan Nete. 61 p. (Summary Report in English). / VMM, 2000. Plan Général de la qualité de l'Eau de l'Yser. 66p. (Summary Report in French). / (more elaborate versions of the GWQPs are available on cd-rom – only in Dutch).

Water Quality plans in Flanders (Belgium) – Approach and experiences. Note. 25 p. (available on CIRCA).

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Title: **No: 3**

WATER INTEGRATED EMISSIONS INVENTORY (ETC-WATER) (France)

Type of impact:

Increasing loads of pollutants, eutrophication

Type of pressure:

Point and diffuse sources of OM, P, and N from households, industry and agriculture.

Type of analysis or tool:

Use and organisation of the already existing national and international statistical sources for the purpose of emission calculations.

Information and data requirements

NB: all data can be considered at a regional and time level and adjusted from monitoring for any actual source or type of source (point/diffuse).

Point source – households: number inhabitants x pollution factor (PE)

Point source WWTP: sampling results of discharges

Point source – industry ((only companies >400 fiscal PE)): Loads by pollution factor and sampling results of discharges

Point source – agriculture: animals: inventories (number of animals x excretion factors), per species, region.

Diffuse source – households: number inhabitants x pollution factor x reduction factor, impervious urban areas

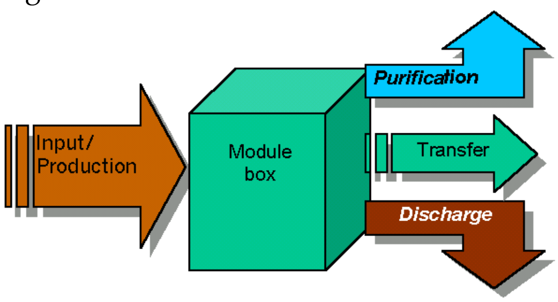
Diffuse source – industry : impervious industrial areas

Diffuse source – agriculture: - Use of fertilisers; model for calculation of losses of nutrients.

Brief description including figures

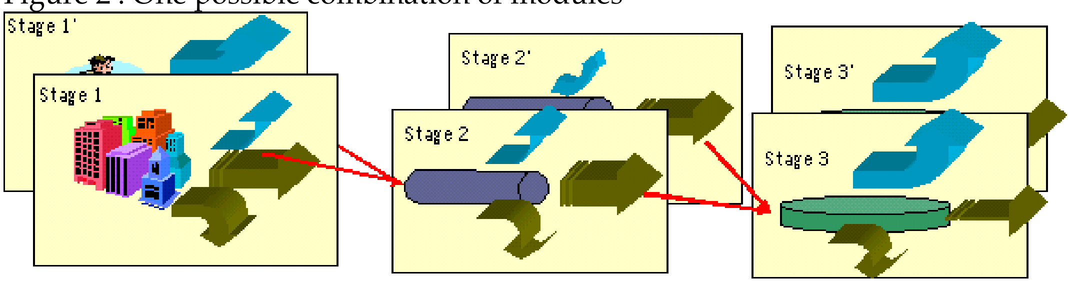
The methodology

Figure 1: The basic module



All emissions are computed as network of elementary modules, to systematise calculations (Fig. 1).
A module receives or produces a certain amount of pollution, purifies a part of it, discharges another part and transfers the remaining quantity to the module downstream (Fig. 2).
This schematisation allows any type of aggregation and presentation of final results (e.g., part of industrial effluents purified in domestic treatment plants.)

Figure 2 : One possible combination of modules



Depending on the organisation of the information system, each country has its own procedures and different data and information are available. This can also be the case at the national or regional level. To overcome these difficulties, the methodology developed in the Loire Bretagne Basin in France proposes to use the best possible data available at the most disaggregated level and coefficients when the data do not exist. The main advantage of this is to have a clear overview of the existing information system. The inventory can be completed and improved when data becomes available or the quality of this data improves and nonetheless to produce information, even if the raw data do not exist in a suitable form.

This of course needs some expert judgement and also a clear presentation of the calculation steps but allows the use of data and information coming from different organisations. This is also economically sound in using the best information and data already available.

Another main idea of the methodology is that the different types of emissions can be described with the same conceptual model. Any emission process is analysed as a combination of modules or steps, thus enabling simple data processing and multi-purpose reporting.

The application

Using this methodology, the project was applied on the so-called „Loire-Bretagne Water Agency" with the following geographical unit, temporal unit, sources and substances.

The area concerned by the Loire-Bretagne water agency extends over 156,217 km2. At the catchment level, the territory is broken down into 16 catchments, 12 for the Loire river and its tributaries, 3 for Brittany and 1 for Vendée.

At the administrative level, it extends over 10 Regions (NUTS2) and 31 "départements" (NUTS3), both being only partly included in the Water agency area. The 7281 municipalities (NUTS5) are totally included in the aforesaid area and the data were considered at this level.

Agriculture is one of the main activities: two-thirds of French livestock is grown on this area, as well as two-thirds of the slaughtering and meat processing activity. Half of the national milk production and derivatives also comes from this area.

Measurement habits concerning water in France are based on the mean value of the month of maximal activity and given in tons per day. However, many statistical data are available only yearly, based on the civil year and the data are considered at this level.

The methodology has the ambition to build a unique system and thus to cover all the sources. For the purpose of this exercise, Ifen decided to collect only the data on emissions liable to reach the inland waters quickly. The sources identified were agriculture, industries and domestic.

The three substances studied are organic matter, and the nutrients Phosphorus and Nitrogen.

The data used have many different sources, the main criteria is the potential availability for the whole country with the same organisation.

The main interest of the methodology is to consider all the main sources and all the data available concerning these. It integrates all the available data to provide trends and evaluations of the relative part of each source in the overall pollution.

It's easy to change one hypothesis or one set of data and recalculate the results. Another point to highlight is that all the hypothesis and calculations are transparent and can be adapted to one specific condition or the use of one specific calculation model.

Some results

Figures 3 and 4 show the results at an administrative level that is the „departements" (pink lines and one chart for each). For the administrators of those regions it is important to know the proportion of emissions or raw pollution between sources and the main source of each substance. In this example the main source of organic matter is domestic. Regarding the quantities assessed, there is a huge difference between the raw and the global pollution: many processes occur along the transfer of the pollutant from its production to its discharge into water. The flexibility of the approach allows the results to be utilised at different administrative levels like the region or the „departement". This is also possible at the hydrographic level: the 16 catchments of the Loire-Bretagne Water Agency.

Finally, it is also possible to aggregate different sources or to focus only on one source to allow the comparison between zones as regards the quantities discharged into waters.

In fact the only limit of these exercises is the original scale of the data: if the original data is available at the regional level, it is not possible to represent the results at a smaller geographical scale like the „commune" level. It is then very important to use the most disaggregated data to allow the maximum flexibility.

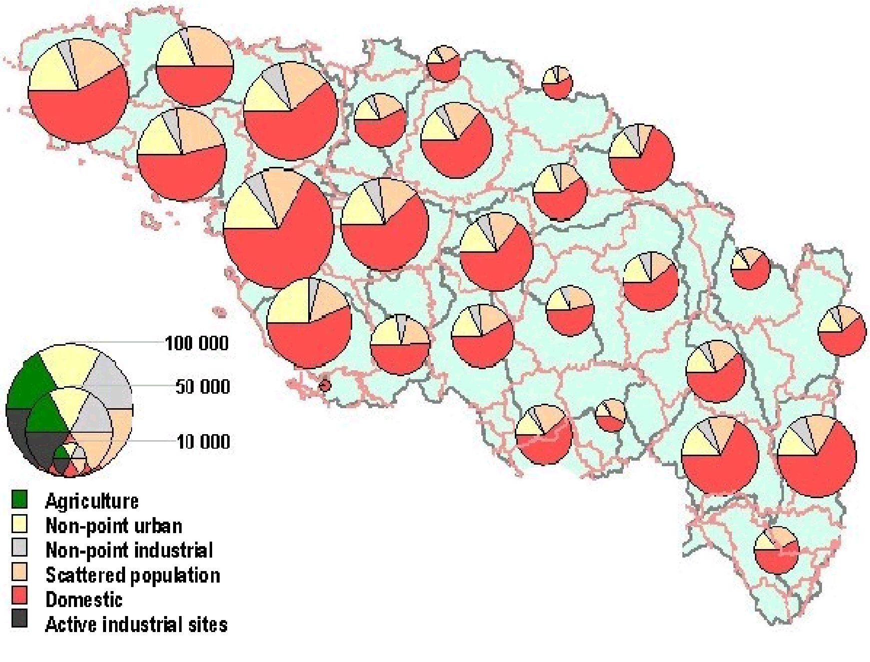


Figure 3: organic matter raw pollution apportionment between departements (BOD5 in kg/day)

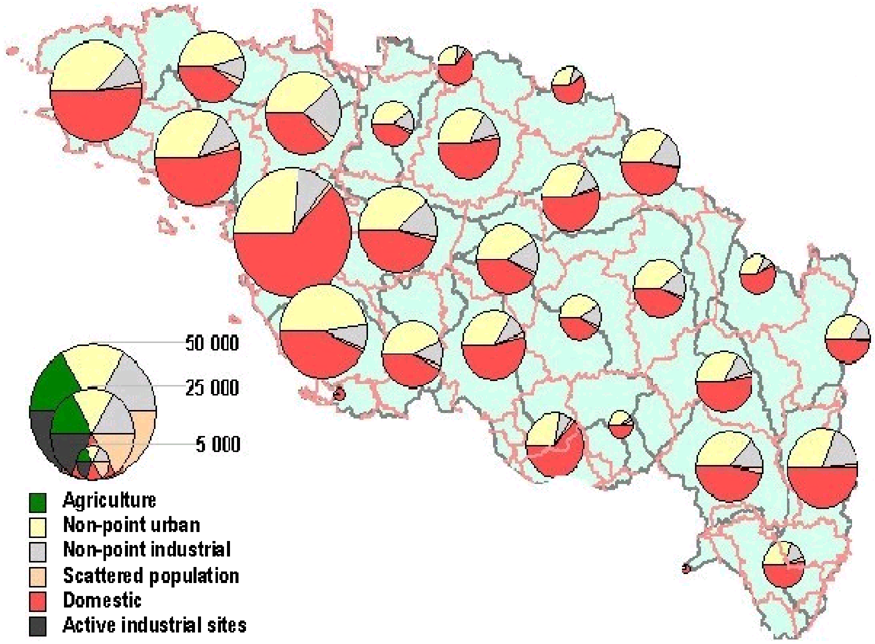


Figure 4: Organic matter global pollution apportionment between departements (BOD5 in kg/day)

References

Fribourg-Blanc, B. 2002. *EUROWATERNET-Emissions A European Inventory of Emissions to Water: Proposed Operational Methodology, draft 4*, provisional, Medmenham, European Topic Centre on Inland Waters, p.65, English

Detailed results available on CD-Rom (in French), apply to Philippe Crouzet

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Title: **No: 4**

CARTOGRAPHIC MODELLING OF WATER USE SYSTEM

Type of pressure:

Water abstraction

Type of analysis or tool:

Tools for Water Balance description ("Consumption and Water Management Indexes")

Information and data requirements

Maps of natural water resources, of water demands (urban, industrial, agricultural), of additional water from desalting processes and interbasin water transfers.

Brief description including figures

The objective of this practice is to have an evaluation of the pressure of spatial distribution of water demands on water resources.

A distributed model calculates the risk of water scarcity from the information of natural water resources and water demands. Figure 1 shows the procedure carried out by the model for each cell. The area selected for the cells of the grid used in the model is 1 km2, this gives a total for Spain of 500.000 cells.

The potential water resources available (surface and ground water) are determined from the natural resources (renewable resources generated in Spain), which are part of the natural water resources that represent the potential total water available.

The difference between total water resources and potential water resources represent the environmental requirements. These resources cannot be accounted to reach the productivity objectives of the system. Only the rest of the water resources (potential water resources) are the ones that can be used in the system and therefore are the only ones included in the water balance (between water resources and demands).

The additional water from desalination processes (Fig.2) should be added to the potential water resources.

Another factor that should be considered is whether any water transfers are presently in operation. These water transfers do not increase the potential water resources at national level but they modify their distribution (Fig.3).

The total demand (water abstraction) is the addition of urban, industrial and agricultural demands. However water returns should be taken into account, which come back to the natural water system and may be used downstream in the basin. This is the reason to separate the consumptive and non- consumptive fraction of each one of water uses. In this way the consumptive and non- consumptive water demand for each one of the water uses can be calculated. The addition of these two fractions gives the total demand (Fig.4).

For each one of the grid cells the water balance is calculated between the potential water resources and the total consumptive water demand. This balance allows maps to be obtained with the spatial distribution of water deficit and water surplus

(Fig.5 and Fig.6). These maps are only illustrative in character since they are the first approach to the problem. As it is known, water is not used in each cell in isolation.

Therefore a spatial aggregation is needed, which has been based on the water management units defined in the Basin Water Plans. This allows the water deficit and water surplus to be identified in the different management units included in each of the basins (Fig.7 and Fig.8). The aggregation of all grid cells of each basin shows the total balance of the basin (Fig.9 and Fig.10).

The processes explained above assumes that all the potential water resources generated in the system, plus the possible additional water from desalination processes and/or water transfers are fully used in the system.

The previous statement also assumes that the necessary infrastructure to use all the water resources are available and that the water is of the required quality for each use. Therefore the only water supply limits would come from limitations of the available water resources.

A system will be said to be in deficit when it cannot supply consumptive use demand, although it has the necessary infrastructure and the required water quality. On the other hand a system in surplus does not mean it has no water supply problems. This may occur if the necessary infrastructure required is not in place or if the required water quality has not been achieved.

To balance the water required with consumptive demands, it is assumed that water reuse in the system is the maximum possible.

This deficit and surplus are of different levels and will also depend on the size of the systems.

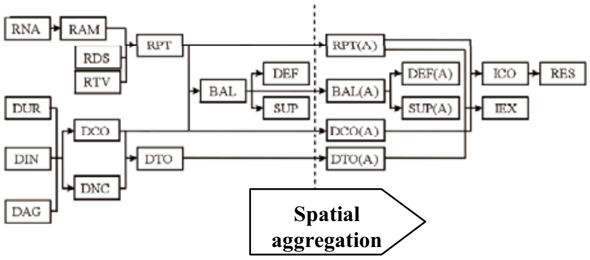
To try to clearly show the water management index and the water consumption index (Introduction à l´économie générale de léau Erhard-Cassegrain and Margat, 1983), they are used to show a map of water scarcity risk (Fig.11 and Fig.12).

The water management index is the result of dividing the total water demand and the potential water resources. It has to be pointed out that a water management index near or larger than "1" may not mean, in some cases, a water scarcity. This is because if the water abstractions are not concentrated in a specific area, part of the water returns might be used downstream.

The water consumption index is obtained by dividing the consumptive demand and the potential water resources. This ratio can also be used as an indicator of scarcity risk. A value greater than 0,5 could indicate "eventual" scarcity, in the other hand if the value is near 1 could mean that the scarcity is "structural". A low value of water consumption index indicates that water resources have a very low use.

It can be observed that the deficit system has a water scarcity of a structural type. In this system the potential water resource is systematically lower than the level of water consumption that is trying to reach.

But there are a number of systems that have water surplus but also have the risk of suffering an eventual water scarcity. The reason for this is that their levels of water consumption are relatively close to the potential water resources. In these systems a number of successive dry years might produce water supply problems because the lack of enough water resources in those years.



RNA	Natural Resources	RDS	Desalinated Water	DEF	Deficit
DUR	Urban Demand	RTV	Transferred Water	SUP	Surplus
DIN	Industrial Demand	DCO	Consumption Demand	ICO	Consumption Index
DAG	Agricultural Demand	DNC	Non-consumption Demand	IEX	Management Index
RAM	Environmental Requirements	DTO	Total Demand	RES	Risk of scarcity
RPT	Potential Resources	BAL	Balance	(A)	Added

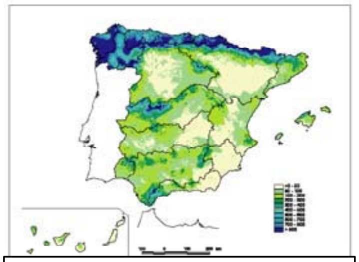


Figure 1. Natural water resources (mm/year)

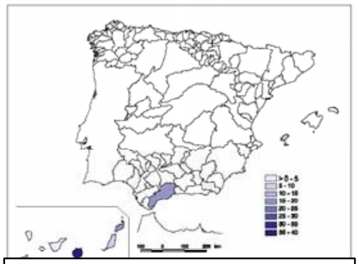


Figure 2. Desalinated water (Mm^3/year)

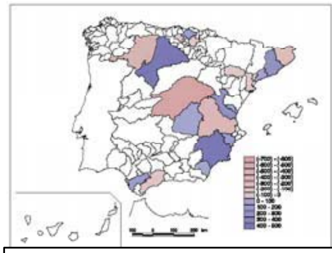


Figure 3. Transferred water (Mm^3/year)

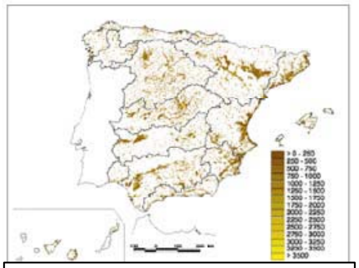


Figure 4. Total demand (mm/year)

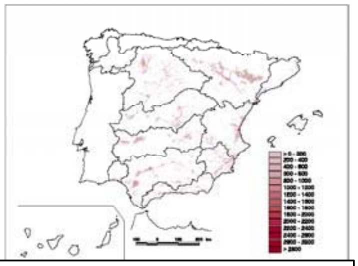


Figure5. Deficit spatial distribution (mm/year)

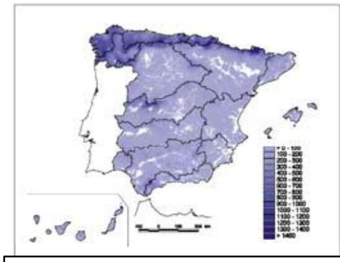


Figure 6. Surplus spatial distribution (mm/year)

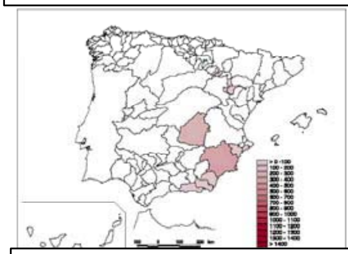


Figure 7. Deficit aggregation in water management units (Mm^3/year)

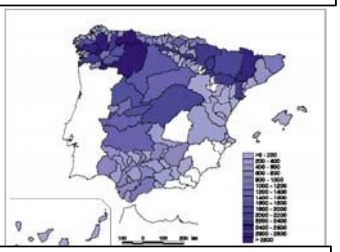


Figure 8. Surplus aggregation in water management units (Mm^3/year)

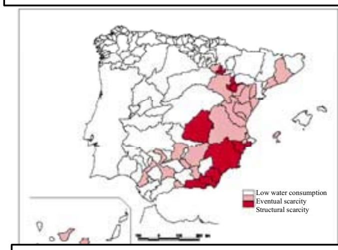


Figure 11. Water scarcity risk in water management units

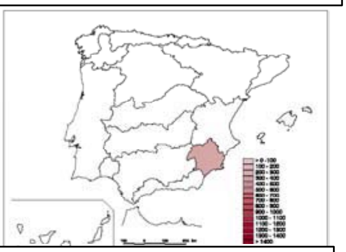


Figure 9. Deficit aggregation in basins (Mm^3/year)

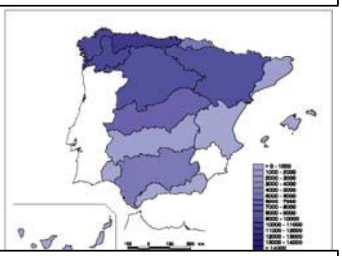


Figure 10. Surplus aggregation basins (Mm^3/year)

Figure 12. Water scarcity risk in basins

References

MIMAM (2000), Libro Blanco del Agua en España. (Ministry of Environment (2000),White paper on water in Spain) Language: Spanish

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Title: **No: 5**

DIFFUSE POLLUTION CASE STUDY: GUADIANA RIVER WATERSHED (Portugal)

Type of impact:

Increase of nutrients loads that can lead to eutrophication problems

Type of pressure:

Diffuse sources of P and N based on land use.

Type of analysis or tool:

A simple methodology was developed on a grid-based water quantity and quality model for mean annual values. Integration of Geographical Information Systems (GIS) it is an important tool that will allow characterising the spatial variability of the watershed by using spatial analysis tools.

Information and data requirements

Physical watershed characteristics, land use and topographic, and hydrological characteristics, precipitation/runoff, together with values of nutrients exportation.

Brief description including figures

Methodology

The first step is to create a mean annual runoff grid based on a distributed hydrological model. In this work, the methodology used is described in GOMES (1997), which is based on Temez aggregate model, implemented cell by cell in A.M.L. language in Arc/Info-Grid. The equations of this model, which rule evapotranspiration, water retainance in soil, infiltration and runoff process, are applied to each cell. This model uses precipitation (mm) and potential evapotranspiration (mm) as input variables and has 3 parameters, a flow parameter, a maximum retention of water in soil (mm) and a maximum infiltration rate (mm).

Runoff (mm/year) = f (precipitation, evapotranspiration, parameters)

Pollutant loads need to be assigned to each cell in order to calculate loading of pollutants in a river system. The combination between distributed maps of the watershed characteristics, namely land use and geology, with the exportation coefficients of phosphorus, and will allow estimating of the nutrient content that reaches to the streamlines (Table I).

Table I Export values of phosphorus E_P and nitrogen E_N (mg m^{-2} $year^{-1}$) (JØrgensen, 1980)

Landuse	Ep Geological classification		En Geological classification	
	Igneous	Sedimentary	Igneous	Sedimentary
Forest				
Range	0.7 - 9.0	7.0 - 18.0	130 - 300	150 - 500
Mean	4.7	11.7	200	340
Forest + pasture				
Range	6.0 - 16.0	11.0 - 37.0	200 - 600	300 - 800
Mean	10.2	23.3	400	600
Agricultural areas				
Citrus	18.0		2240	
Pasture	15.0 - 75.0		100 - 850	
Cropland	22.0 - 100.0		500 - 1200	

The linkage between the coefficients of nutrients to the polygon coverage of land use will be converted to a grid with the same cell size as the runoff map and this will be the load map. Using spatial tools of a GIS will allow integration of the distributed runoff map and the digital terrain model (DTM) of the watershed to obtain the accumulated flow in the streamlines. The same amendments are made to the phosphorus load map. This will result in the annual concentration of phosphorus in the streamlines.

Concentration (mg/l) = Load (mg/year) / Flow (dm³/year)

After the calculation of the concentration values it's possible to compare them with nutrients data measured in the water quality sampling stations to validate this methodology. Nevertheless the nutrients measured in each station reflects the total pollution that reach the streamline – point and non-point.

Application

This methodology was applied to the Guadiana river, and only for phosphorus because it is the limiting factor which determines the development of eutrophication. This river is an international basin, with a total area of 66 860 km^2 and has it's headwaters in Spain, and only 11 600 km^2 of the area is our national basin.

This river has an important role in the south of Portugal, a region with drought problems. The agricultural activities and animals in pasture have a great impact in this basin as non-point pollution sources, which causes a large amount of nutrient exportation to the water and soil.

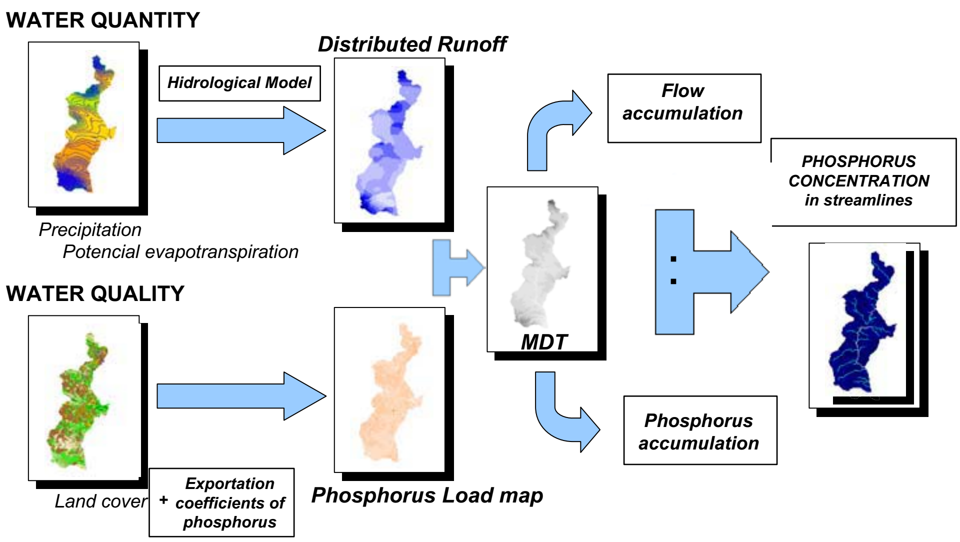

Figure 1 – Methodology application to Guadiana River (Portuguese basin).

Results

For modelling the runoff map it's necessary to have the distributed maps of precipitation and potential evapotranspiration. After calculating the distributed maps of runoff and phosphorus load (Figure 2) it's necessary to integrate these two variables in the streamlines. The accumulated flow and the accumulated phosphorus load in the streamlines is made by using a flow direction map originated from DTM, that shows the direction in each cell that the runoff takes to reach the streamlines. The concentration values are calculated in mg/l of P by dividing the load values with the flow values.

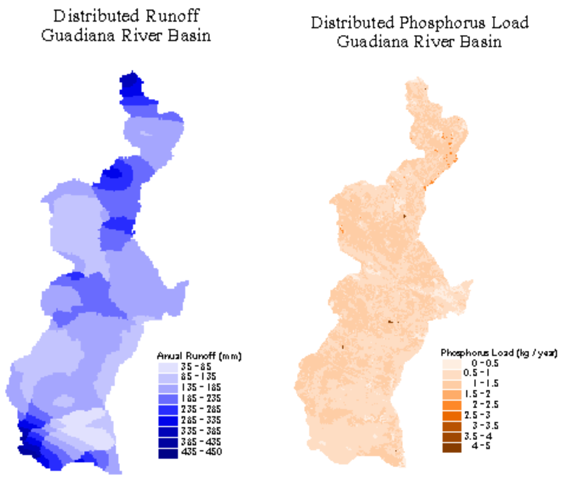

Figure 2 - The input distributed maps to calculation of phosphorus concentration.

A comparison between the estimated values of P and the observed values was made in the water quality sampling stations in the rivers (Figure 3). This Figure also shows the main point sources pollution, industrial and domestic. They are spread all over the basin but more concentrated in the North part.

By comparing these two values (observed versus estimated), we shouldn't forget that estimated value only takes in account the diffuse pollution provoked by land use. It's missing the correspondent impact of animals in pasture and point sources pollution to have the total phosphorus concentration in the rivers.

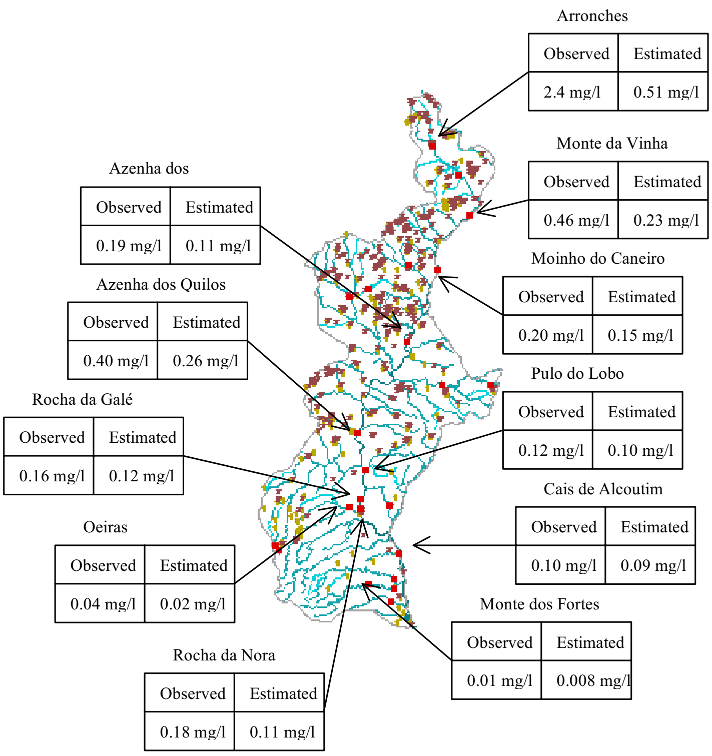

Figure 3 - Comparing the observed values with the estimated in the water quality stations.

In general it can be verified that the higher values of phosphorus concentration are in the North part of the basin and the estimated values are more approximated with the observed ones in the South. This can be explained because there are less point sources in this zone, which reflects the contribution of diffuse pollution.

Regarding sampling data, (Figure 4) it can be concluded that a dilution of the phosphorus concentration is observed as coming to the South part of the basin. Also, in terms of percentage, the estimated values related to the observed ones increase as they come towards the South part of the basin, which illustrates more contribution of the non-point pollution to the total amount of P.

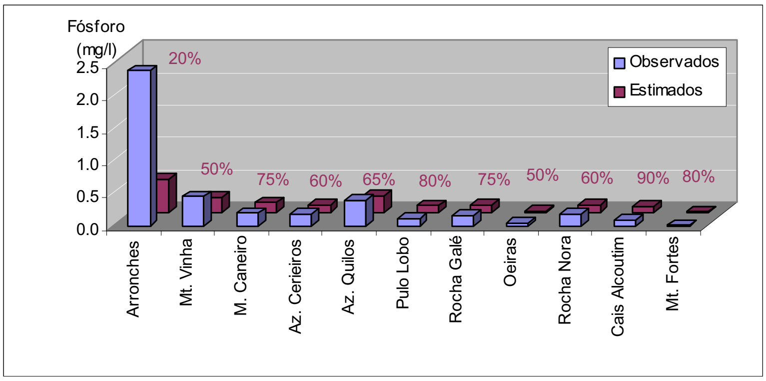

Figure 4 – Comparing phosphorus concentration (observed versus estimated) and their relation in terms of percent.

References

JØrgensen, S.E., (1980), *Lake Management*, Pergamon Press Ltd., UK.

Gomes, F., (1997), Modelação Hidrológica Distribuída: Aplicação à bacia do Guadiana. Universidade Técnica de Lisboa, Instituto Superior Técnico.

Novotny, V., Olem, H., (1994), *Water Quality. Prevention, Identification and Management of Diffuse Pollution*. Van Nostrand Reinhold, New York.

Olivera, F., Maidment, D. R., Charbeneau, R. J., (1996), Spatially Distributed Modelling of Storm Runoff and Non-Point Source Pollution using Geographic Information Systems. University of Texas at Austin.

Quadrado, F., Gomes, F. et al, (1996), Programa de Despoluição da bacia do rio Guadiana. INAG, DSRH.

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Title: **No: 6**

GROUNDWATER ABSTRACTIONS (Denmark)

Type of pressure:

Lowering of groundwater table, reduction of streamflow

Type of impact:

On groundwater: Alterations in directions of groundwater flow, possibly leading to saline intrusion. Also deterioration of groundwater quality as a result of e.g. upwelling, oxidation in upper layers, increased infiltration.

On surface waters: Reduced dilution of chemical fluxes from e.g. wastewater, modified ecological regimes (resulting from change in a long range of parameters, such as changes in temperature of water in streams as a result of reduced influx of groundwater!).

Type of analysis or tool:

Monitoring: Measurements of changes in both groundwater levels (soundings), and changes in groundwater chemistry (e.g. chloride, sulphate, iron, nickel) to quantify effect of groundwater abstraction.

Model Approach: 2- or 3-dimensional hydrologic models (numeric computer models) used to assess changes in groundwater flow as result of abstraction, and also to calculate water balances. More refined 3-dimensional models can be used-to assess interactions with surface waters and calculate e.g. changes in streamflow.

Information and data requirements

For the application of models often-extensive requirements have to be met for input data. These data are often derived from existing monitoring data and pumping tests of groundwater wells.

For an adequate representation of the hydrological system you need distributed values for a long range of parameters (e.g. hydraulic conductivity and porosity), that are specific for the hydrologic system modelled and also for the geographical setting, to ensure valid results of the model. The more complex and accurate the model, the more comprehensive the data-requirements.

Furthermore, data for both calibration and validation of models must be available in order to test, if the model can precisely reproduce the responses of the hydrological system. These data can often be extracted from monitoring data, so that one part of the monitoring data are used when setting up and calibrating the model, and another part of the data are held back for later validation of the model.

Brief description including figures

Whereas monitoring directly can document failure to achieve good status for both surface and groundwater bodies, especially for groundwater bodies there is often a need to complement the assessment of impacts with models and calculations of the future impacts due to the inherent time delay of pressures on groundwater bodies.

Water balance models can be used on catchment scale. Both as “simple” conceptual models, but also as more elaborate numerical computer models. They can be used to calculate both amounts in cubic meters available for abstraction, and in this relation also be used in quantification of impact on e.g. surface waters, typically on streams.

This is widely recognised in Denmark, where hydrological models are used both in permitting water abstractions under consideration of the risks of saltwater intrusion or damage on associated surface waters/ecosystems. But also when calculating if remediation is necessary for example to ensure acceptable streamflow – and how it is most appropriately done (e.g. if this should be in the form of reduced abstraction or pumping of groundwater to the stream). In the example below, streamflow has been modelled in the County of Roskilde at different stations in order to calibrate the model and determine the hydraulic and other parameters of the system. The model will subsequently be used to assess the maximum groundwater abstraction permissible under consideration of the environmental objectives of the stream. Especially the low discharges are critical in this respect.

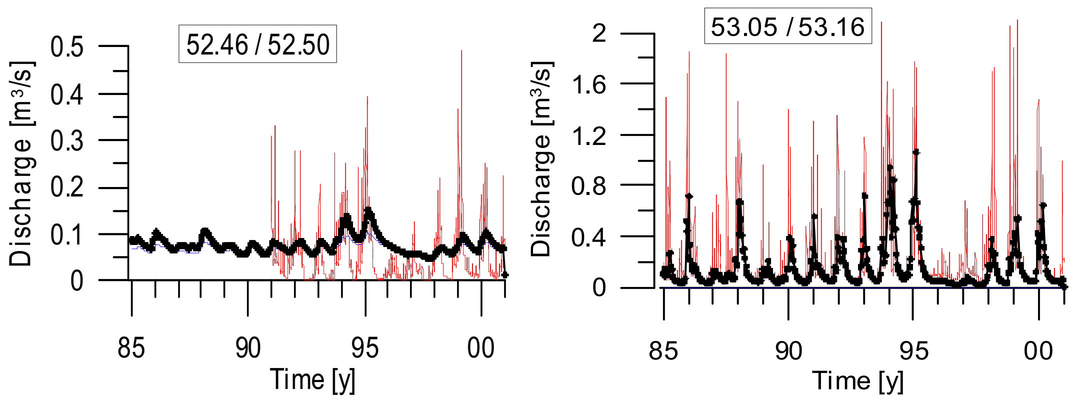

Figure 1: Calibration of hydraulic model on streamflow-data. Thick line: model results. Thin dashed line: recorded discharge. Left a poorly calibrated/determined, and therefore less precise, model. Right a well-calibrated/determined model.

(County of Roskilde (2002): Grundvandsmodel for Roskilde Amt by WaterTech a/s).

Also, the use of computer models makes it possible to make a qualified estimate of travel times for the impact of a given pressure in the form of pollution. This is relevant for assessing the impact on e.g. water supply wells, and also for other cases of groundwater pollution.

Lastly, computer models of hydrologic systems are in relation to groundwater used to delineate groundwater recharge areas. This is highly relevant in tracking the origin of a given impact and thereby the pressure/driving force, and, as a preventive measure, in spatial planning, so as to keep sensitive areas free from polluting activities.

References

County of Roskilde (2002): Grundvandsmodel for Roskilde Amt by WaterTech a/s.

Project report on the state of knowledge of relations and interactions between groundwater and surface waters (including the effects of abstractions). The text is in Danish, but with an abstract in English:

http://www.mst.dk/udgiv/Publikationer/2002/87-7972-157-5/html/default.htm

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Title: **No: 7**

APPLICATION OF THE RIVER SYSTEM SIMULATOR FOR OPTIMISING ENVIRONMENTAL FLOW IN THE RIVER MAANA (Norway)

Type of impact:

Altered flow regime

Type of pressure:

Water flow regulation

Type of analysis or tool:

The models ENMAG, HEC-RAS, QUAL2E, RICE and HABITAT in the River System Simulator (Alfredsen et al 1995) were used in this study.

The modelling approach was to set up and calibrate the model no flow release in the bypass Sections of the river, and simulate the impact of releasing 1 m3/s, 2.5 m3/s, 5.0 m3/s and 10 m3/s water as environmental flow.

How the decision was made based on the model

The scientists judged all model results manually, and a common integrated recommended flow was proposed.

In what ways did the application process represent state-of-the-art?

Three well-known and fully documented models (ENMAG, HEC-RAS and QUAL2E) and two newly developed models (RICE and HABITAT) were integrated with a common database and presentation tools in the River System Simulator. The integration represents the state-of-the-art.

Modeller-end-user communication

The end-user for the project, "The Eastern Telemark River Regulation Association", had established a reference group with participation of local and regional authorities, hydropower companies and local politicians. The project reported the progress to this reference group once a year. In the starting phase of the project, several meetings between two of the modellers and the end-users were arranged. The end-user had established a reference group. The final output of the project was seven scientific reports and one summary report.

Information and data requirements

The data collection strategy for hydraulic, habitat and fish data was to collect data intensively over shorter periods where water was released back into the river. Other data were collected on a continuous regular (monthly, daily and every 10 minutes) basis. Several of these models require the same input data. The following data were collected:

Technical and hydrological data for the power plants and the reservoirs in the system to run the ENMAG model.

Cross-section and water level data to run HEC-RAS, QUAL2E and RICE models.

River ice cover, water and air temperature data for the RICE model.

Data on the water quality parameters total P, total N, bacterial count, coliform and thermo tolerant coliform bacteria, pH, turbidity and water temperature were collected for the QUAL2E model at twelve sites along the river and at the outlet of several power plants. These data were collected once a month during a period of 14 months as well as during several periods of test water release to the river.

Water depth, current velocity and substrate size were collected for the HABITAT model along 5-12 transects at five fish habitat stations. Fish habitat use data was collected by snorkelling at the same stations during summer situations.

Brief description including figures

The River Maana in the central southern Norway about 150 west of Oslo is regulated with a large dam in the mountains and a total of 5 hydropower plants. The licence for the regulation was due for re-licensing, and this study was done to analyse environmental flow requirements with respect to water-covered area (aesthetics), trout rearing habitats, water quality, ice conditions and power production. The River System Simulator (Alfredsen 1995) was used to simulate and integrate the impacts of a range of 1-10 m3/s environmental flows to be released in the bypass sections of the two most downstream hydropower plants.

The affected bypass sections are of approximately 6 km and 8 km. Fish habitat simulations were done in detail at 5 selected representative reaches of 25, 48, 59, 60 and 286 m length. The other subjects were studied on the whole river part of 14 km.

References

The study is reported in several openly available Norwegian reports, also including one summary report:

Harby, A. (ed). (2000) Vassdragssimulatoren for Maana. Hovedrapport. SINTEF, Trondheim, Norway. (in Norwegian).

An article for international publication is submitted to Environmental Modelling and Software. Parts of the study is reported in:

Harby, A. and Alfredsen, K. (1999) Fish habitat simulation models and integrated assessment tools. International Workshop on Sustainable Riverine Fish Habitat, April 21-24, Victoria, B.C., Canada.

References to modelling tools:

Alfredsen K., Bakken T.H. and Killingtveit (eds) (1995) The River System Simulator. User's Manual. SINTEF NHL report 1995.

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Title: **No: 8**

AN APPROACH FOR ASSESSING ALTERATIONS IN THE RIVER WATER FLOWS PRODUCED BY RESERVOIRS

Type of pressure:

Water flow regulation

Type of analysis or tool:

Index for the maximum potential alteration of the natural water regime produced by water flow regulation.

Information and data requirements

- Map of water storage capacity upstream of any point of the hydrological network.
- Map of natural water yields.

Brief description including figures

The objective of this practice is have a straightforward index to evaluate the maximum potential alteration that could be produced by the water flow regulation.

The map of maximum potential alteration of the natural water regime produced by water flow regulation was made by calculating, using GIS techniques, the ratio between the map of annual water yields and the map of water storage capacity upstream of any point of the hydrological network.

Regulation dams can produce the greatest alteration on the temporal flow regime. Indeed regulation dams are constructed to modify the natural river discharge according to human requirements and such activity alters the natural water regime. The degree of degradation at any point of a river depends on three parameters: the volume regulated upstream of that point, the relative amount of water regulated related to the resources flowing through the river (in other words the storage-to-flow ratio), and the reservoir operational management.

The alterations produced by the management of the reservoir could be null if it reproduces the natural regime, or could make a total alteration of the regime if it stores all the resources and no water is released to the river. This latter case represents the worst effect that a dam can produce to the river flow, and it can be used to quantify the potential alteration of the natural water regime. First, a map of water storage capacity shows the volume of water that can be regulated upstream of each point. Then if the map of annual water yields is divided by the map of water storage capacity, the map of maximum potential alteration of the natural water regime produced by water flow regulation will be obtained.

Figure 1: map of water storage capacity shows the largest volumes exceeding 5.000 Mm^3, which are in the low courses of the large rivers (Guadalquivir, Ebro, Tajo, Duero and Guadiana), while there are some small basins which hardly reach 1.000 Mm^3 (Norte, Sur, C.I. de Cataluña, Galicia Costa and Segura).

Figure 2: shows the map of natural water yields

Figure 3: shows the map of maximum potential alterations by flow regulation. It presents a very different aspect compared to the water storage capacity map. Basins with very high absolute storage capacity, as the Ebro, show little altered regime due to its great natural contribution, while other rivers with also large contribution presents much greater possibilities of alteration (Tajo or Guadalquivir).

Furthermore, it must be recalled that we are referring to a maximum potential alterations, thus real alteration can be much lower than these. If one thinks, for example, in the frequent case of hydropower damming with high storage capacity and also high percentage of water returns, the potential alteration of natural waters regime downstream would be very high, but the real alteration produced would be very small.

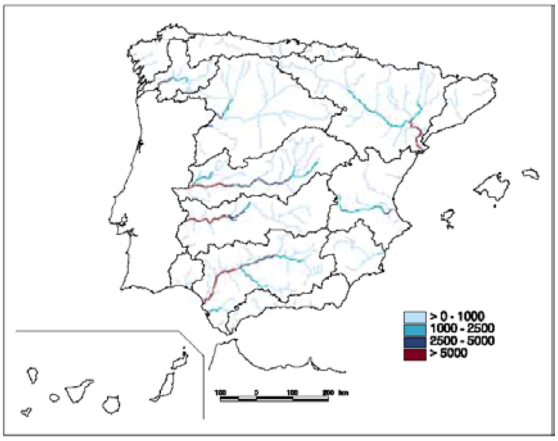

Figure 1: Map of water storage capacity upstream of any point of the hydrological network (Mm^3).

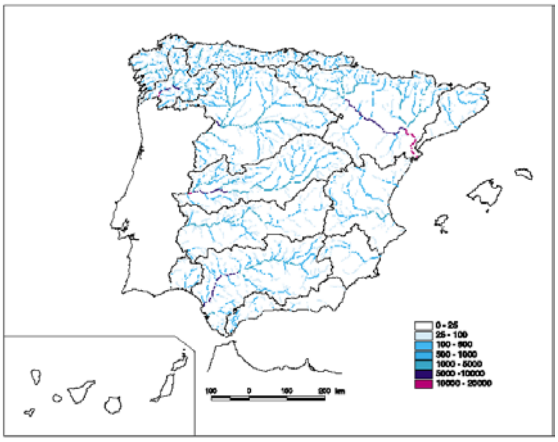

Figure 2: Map of natural water yields (Mm^3/year) Average (1940-1996)

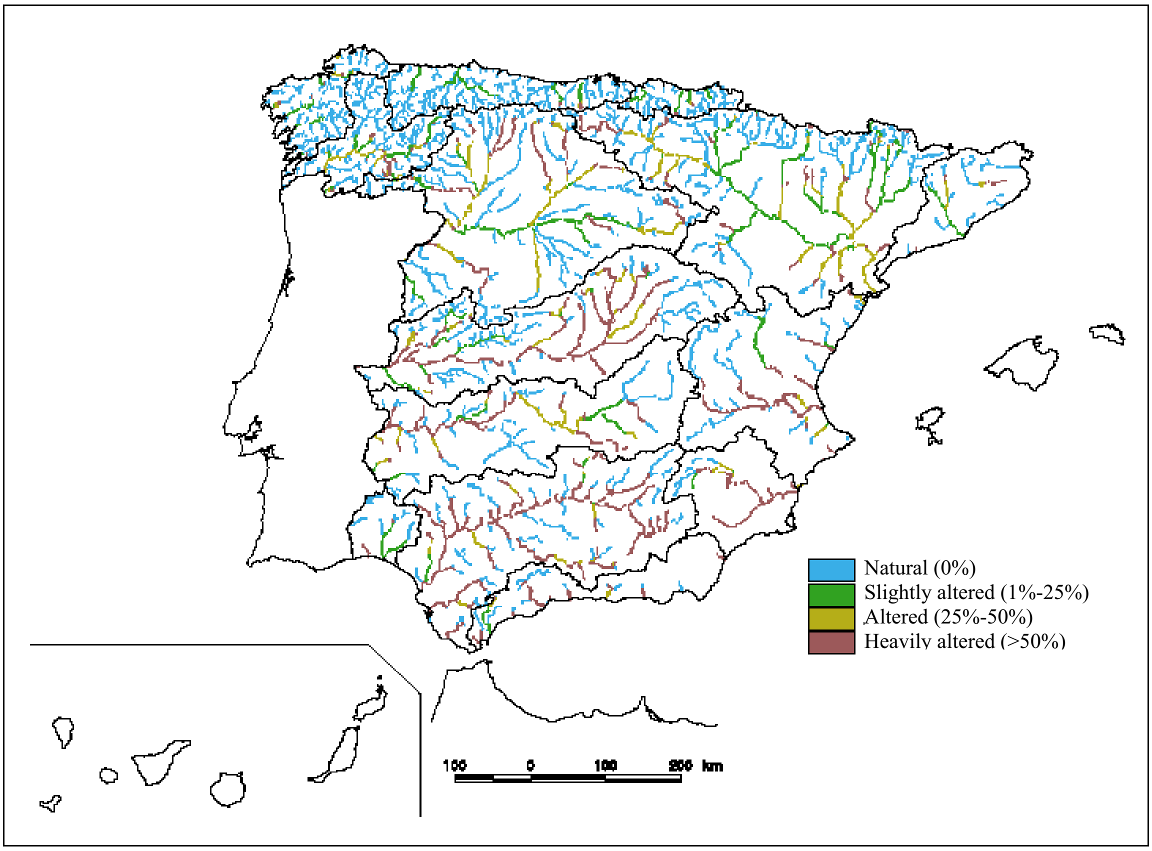

Figure 3: Map of maximum potential alterations by flow regulation.

References

MIMAM (2000), Libro Blanco del Agua en España. (Ministry of Environment(2000), White Paper on Water in Spain) (Language: Spanish)

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Title: **No: 9**

HOW TO REPORT ON MORPHOLOGICAL ALTERATIONS RELATED TO HUMAN PRESSURES? (Netherlands)

Type of impact:

Altered flow regime results in significant changes of natural dynamics and habitat conditions.

Type of pressure:

Substantial change of estuarian flow characteristics resulting in morphological changes in the estuary

(Driver: Current and future demand for shipping requires deepening and widening of navigation channel in Westerscheldt estuary.)

Type of analysis or tool:

During the analysis there were no uniform criteria or reference conditions available from the HMWB-group or REFCOND for transitional and coastal waters. Therefor a set of objectives and indicators from the Long Term Vision for the Scheldt (TWG Scheldt Commission) is used as a preliminary set of reference conditions.

Information and data requirements

Data on habitat area (GIS), water depth, flow regime, sediment composition and sand transport.

Brief description including figures

The Westerscheldt is the major shipping channel to the ports of Antwerp and Vlissingen. In order to support economical developments the navigation channel has been deepened to grant access to larger ships and reduce dependency of the tidal changes. In the Westerscheldt estuary the continuous dredging and dumping activities related to this deepening have a major effect on the quality status of the system. Important effects are subsequent changes in morphology and habitat composition within the estuary. The Westerscheldt can be characterised as a transitional water and presumably as 'heavily modified'. This means with respect to the morphological state of the estuary that certain man-made alterations of the system are accepted as irreversible. This certainly reflects the presence of dikes for safety reasons and also to the navigation channel because of the economical importance. This implicates that the quality objective for this water body is the Good ecological potential, meaning the best possible ecological conditions within the irreversible changes.

The WFD requires an identification and analysis of the significant human pressures, including man-derived changes on hydromorphology. In order to structure the analysis 5 steps have been taken:

Step 1: system characterisation

The parameters of the most important system characteristics (annex II (par.1.2.3., V (par. 1.1.3. and 1.2.3) of the WFD have been used as a starting point for this description.

Step 2: establishing reference conditions and morphological quality objectives

A reference condition of the morphological status that sufficiently meets the WFD quality objective given by GEP had to be described. Such a reference condition was not sufficiently specified and quantified in the available literature. Since a static (geographical of historical) reference condition is not practical to use in a dynamic estuarine system, the objectives of the 'Long-term vision of the Scheldt estuary (LTV)' are used to derive significant pressures and impacts and to identify criteria to monitor system changes. The LTV focuses on the preservation of essential natural dynamics in an estuary. Two major system objectives are used for this purpose: (1) the multichannel system should be kept intact (2) there should be sufficient space for dynamic sedimentation / erosion processes and changes in habitats.

Step 3: Identification of significant pressures

The assessment whether a pressure on a water body is significant must be based on a general conceptual understanding of the pressures (e.g. water flow) and their impacts on the system (e.g. the related changes in morphology and the ecological functioning and habitats of the system). In the case of the Westerscheldt expert knowledge was used to firstly list all potentially relevant pressures and then in a second step to identify the most significant pressures. Significance only becomes meaningful if determined towards an objective or reference condition. The criterion used for the prioritising was the relevance of the pressure for reaching the system objectives as described in the LTV.

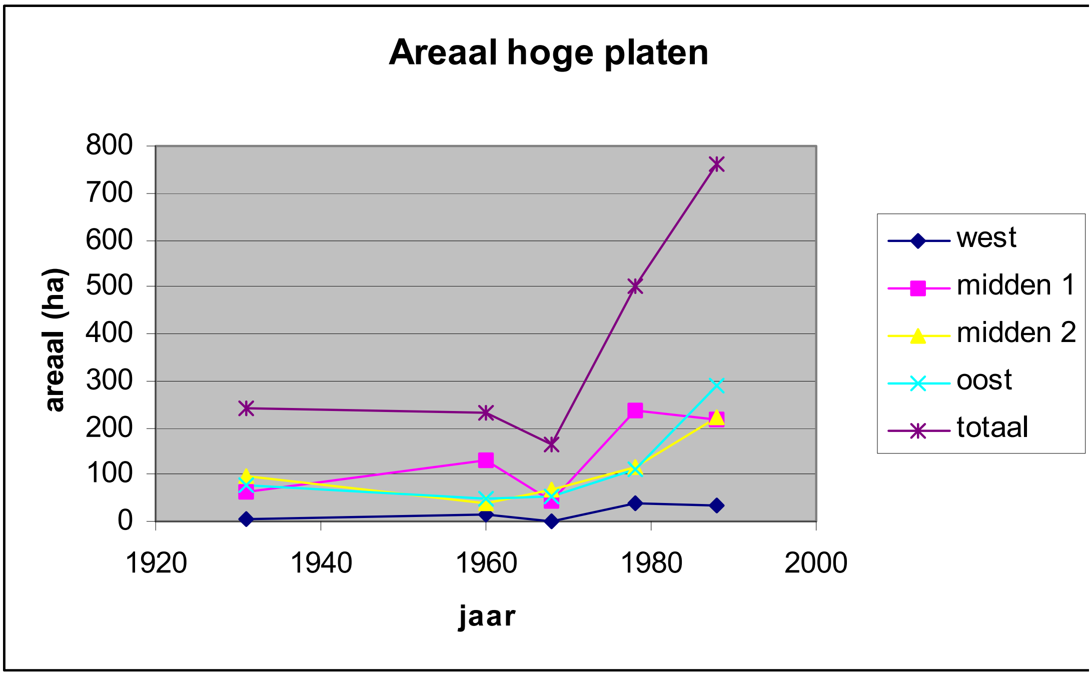
Step 4: Assessment of impacts

Important goal of the first review in 2004 is to identify the major pressures and their impacts. The pressure with the strongest impact is 'deepening and widening of the navigation channel'. Consequently this activity also has the largest potential to meet or fail the future objectives as formulated in the LTV.

Step 5: Identification of relevant indicators for monitoring impacts

The relationship between pressure and impact has been used to identify relevant indicators to monitor morphological changes. For the multi channel relevant indicators seem to be i.a. shore-length of tidal flats, intertidal area, ebb/flood domination, net sediment-transportation, relation primary channel transport versus secondary channel transport. For the objective of enough space for natural dynamics relevant indicators of the height of intertidal flats and lower salt marsh area have been suggested.

Unfortunately the relationship between pressure/ impacts and morphological criteria has not been established thoroughly enough to be able to derive an operational classification system yet, so much depends on expert knowledge. Nevertheless trends away from achieving good ecological status can already clearly be identified for this indicative parameters. (see the graph on increase of area of higher salt marshes which mean that the area of relevant lower salt marsh is strongly reducing). The first review in 2004 is a screening step. It designates the prime aspects that should be treated in the RBMP. For morphology it reveals a number of relevant gaps in knowledge that should be filled in the next steps towards the RBMPs.



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Title: **No: 10**

SCREENING AND IMPACT ASSESSMENT USING EUROWATERNET METHODOLOGY FRENCH APPLICATION (France)

Type of impact:

Organic matter, nutrients, eutrophication, in rivers

Type of pressure:

Point and diffuse sources of OM, P, N, estimated trough their driving forces.

Type of analysis or tool:

Statistical technique to organise use of monitoring data and assess spatial and temporal relationships between pressures and impacts

Information and data requirements

Monitoring stations location and observation raw data,

Catchments structure,

CORINE *land cover*, administrative and catchment limit

Population per NUTS5

Other information can be entered in the stratification system

Brief description including figures

The methodology

Land cover types and population density define the main driving forces that impact river quality. The proportion and combination of land cover types and population density are used to define strata of potential pressures that make it possible to earmark each monitoring station. The stratification process takes into account the sub-catchment and the catchment size as well in order to select stations equally across the whole territory.

The stratification aims at clustering the monitoring stations by groups of identical input discharge. If the strata are well defined, then it is expected that the pollution density (as kg y^{-1} $(km^2)^{-1}$), on the one hand and standard discharge (in m^3 y^{-1} $(km^2)^{-1}$) on the other hand produce concentration data belonging to the same statistical population.

Under these hypotheses, the stratum means and stratum variance can be computed as combinations of point means and variances. Consequently, it becomes possible to compare strata, combinations of strata * catchment and time trends.

The application

Implementation of EuroWaternet in France is now fully operational. A detailed statistical study, using geostatistical processes (multidimensional kriging) demonstrated that 6 strata (dense urban, urban, mixed (urban + intense agricultural), intense agricultural, moderate agricultural, low impact) were sufficient to describe the drivers impacting rivers.

As response to EuroWaternet requirements, 512 sampling stations were selected. For domestic purposes, this selection was extended to ~1500 stations (number is slightly year dependent) which are used for representing the water quality issues, **when statistical indicators are involved**.

In a second stage, the methodology is used to define the optimum share of stations as function of pressures on catchments. An optimum network of 2500 stations was defined and is currently under closer examination. This result is not presented here, since it is not in line with pressures and impacts. However, it is emphasised that quality of monitoring greatly determines the accuracy of impact assessment.

Some results

The stratification can be reported as a map of stratum types per elementary catchment (currently 6210). The colour code in each catchment represents the cumulated expected impacts from the upstream part of the catchment.

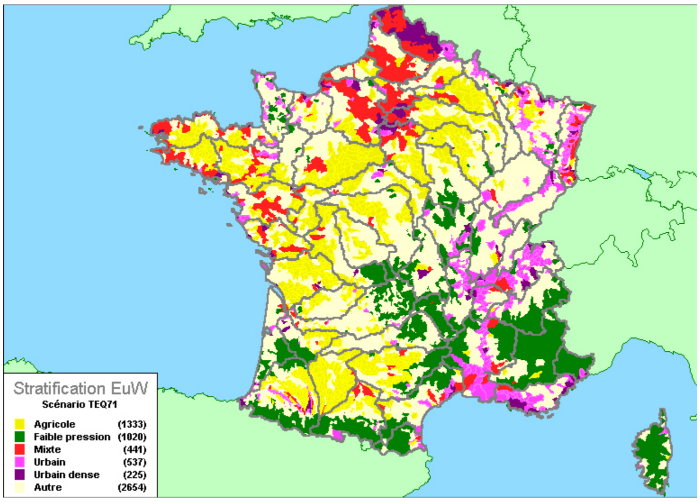
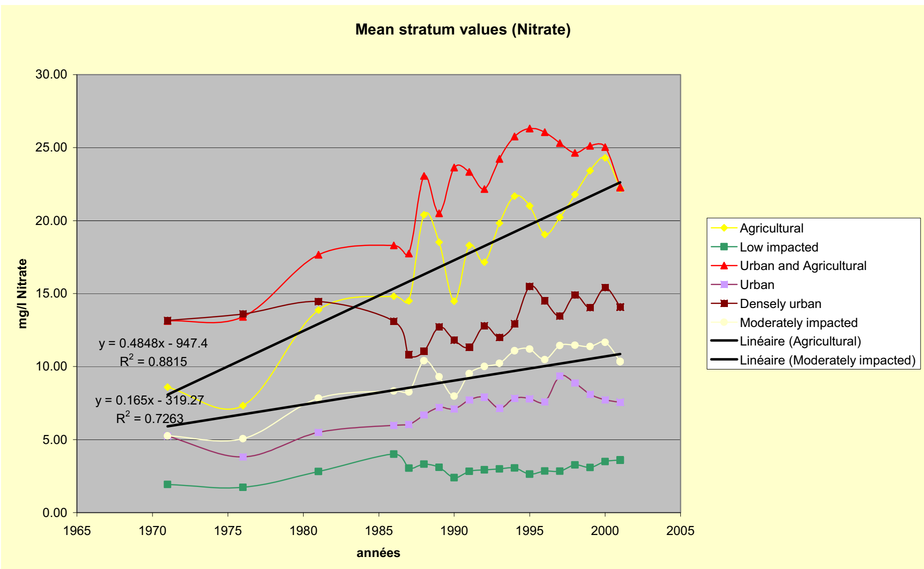


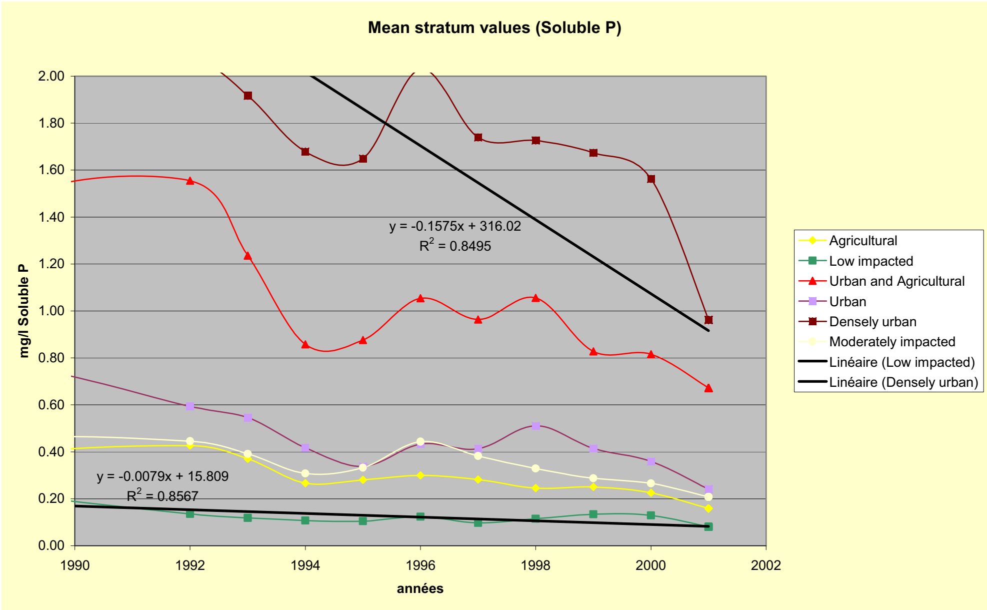
Fig. 1 Current EuroWaternet stratification types used in France.

The stratum type applies to any station situated on the main channel of the river draining any of the 6210 elementary catchments defined. The greyed lines indicate the 55 operational catchments used to force point selection even across metropolitan France.

The foreign part of catchments are considered in the calculations.



In the above example, nitrate per stratum (in this case all French EuroWaternet points are processed) shows clear upwards trends in intense agricultural, mixed and moderately impacted (agricultural) strata. Hydrology effect is not removed from averages, this procedure emphasises the time trend, supposedly in relation with activities.



In the above example, soluble Phosphorus per stratum (in this case all French EuroWaternet points are processed) shows clear downwards trends in all strata. The improvement is very effective in the most impacted strata, in relation to sewage purification and decrease in detergent P-borne. Hydrology effect is not removed from averages. In this case, the quality of relationship would have been improved, since P averages are very sensitive to dilution.

In both exemplified cases, trends, with baseline scenario, can easily be carried out and indicate which water bodies would be at risk or not of failing objectives.

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Title: **No: 11**

QUANTIFYING IMPACT OF PRESSURES AND LIKELIHOOD OF MEETING OBJECTIVES BY MEANS OF THE WATER ACCOUNTS METHODOLOGY (EUROSTAT). FRENCH APPLICATION (France)

Type of impact:

Organic matter, nutrients, eutrophication, pesticides, biological status in rivers

Type of pressure:

Point and diffuse sources of OM, P, N, etc estimated either through their driving forces or actual pressures.

Type of analysis or tool:

The Water Accounts methodology apportions the water quality assessments (not raw concentrations) in proportion of the size of water bodies. This method yields a quantity of quality that can compare with pressures (as loads) or with costs (as amount of money).

Information and data requirements

Monitoring stations location and observation raw data,

Quality assessment method to calculate quality indexes or classes,

Catchments structure and river network structure,

Standard discharges values (average, low flow values) to calculate weighting data.

Brief description including figures

The methodology

Water accounts methodology was designed first to build observation systems representative of the river network structure (whereas EuroWaternet yields representative sample of the monitoring network and responds to different objectives).

Several countries, including France, adapted it on behalf of Eurostat. The aim is to allow comparisons of quality state between catchments or NUTS areas and to make it possible to assess the cost of quality improvement.

The heart of the method is very simple: each river segment has a weight, calculated as length times the standard discharge. This quantity, named SRU (Standard River Unit / UMEC Unité de Mesure des Eaux Courantes) homologous to local energy content can therefore be added, compared and has a finite value, independent of map accuracy.

In a second step, quality assessed (or extrapolated) for each segment is processed as quantities of quality. Since quality classification schemes refer to classes, it becomes possible to match quality related to nitrate with quality expressed as biological indicator, provided the classification scheme is internally consistent.

The most developed state of methodology is now available, after recent French and EEA developments providing a full chain of production from monitoring data to aggregated indexes (catchment and NUTS) and b) comprehensive set of indicators as well as a trial in four countries (Ireland, UK, Slovenia and France).

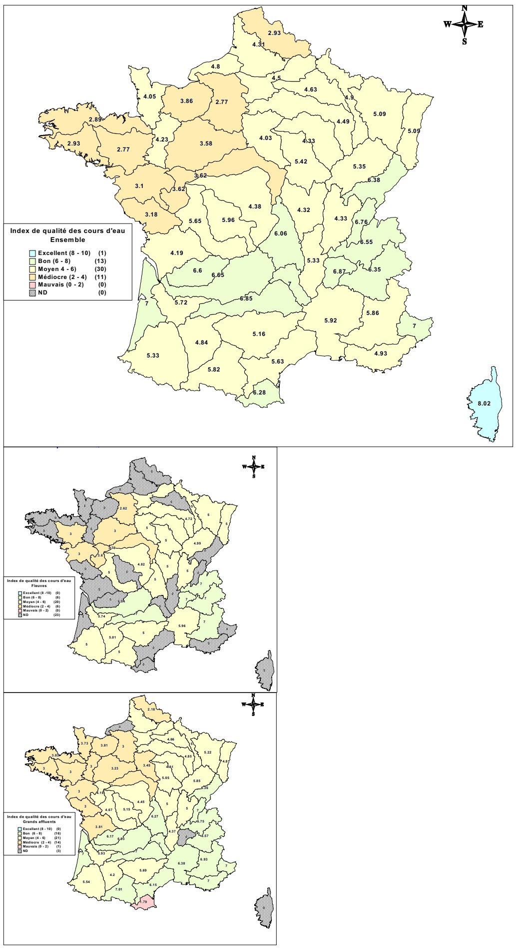
The application

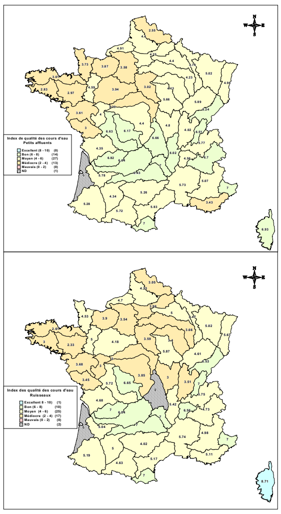
For the time being, the most comprehensive application was carried out in France. However, examples are given for other countries to demonstrate the flexibility of the method.

Thanks to the latest developments, the following information is provided by the application of the software available (in France NOPOLU).

- Quantity of SRU, per quality class, for the different assessment types, if relevant, per river rank, aggregated per catchment (any size type) or NUTS. These quantities directly compare with stock-like units: volume of discharge, amount of money;
- RQGI (River Quality Generalised Index), which is a generalised water quality class encompassing the distribution of quality classes over the aggregation domain (from all river types of a country to a river size class of a catchment);
- Pattern Index, indicating what is the profile of a quality problem of the considered domain of aggregation (mediocre everywhere, good with "black spots", etc.);
- Relative importance index, obtained by comparing the SRU resulting from different quality assessments. For example, comparing nitrate and eutrophication. Quantitative information, for all aggregation units becomes available. Of course, changes in time can be compared as well.

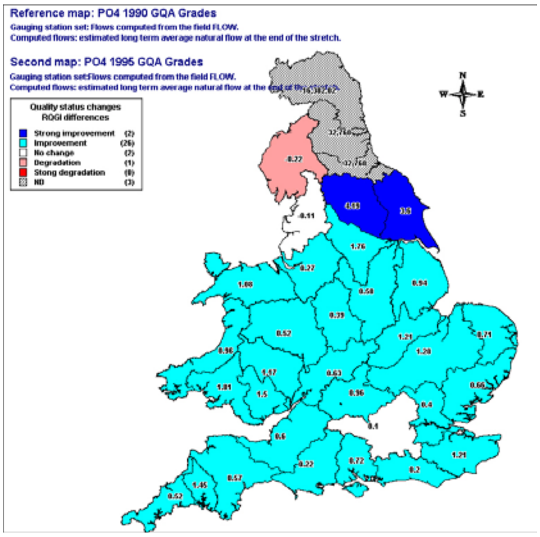
Some results

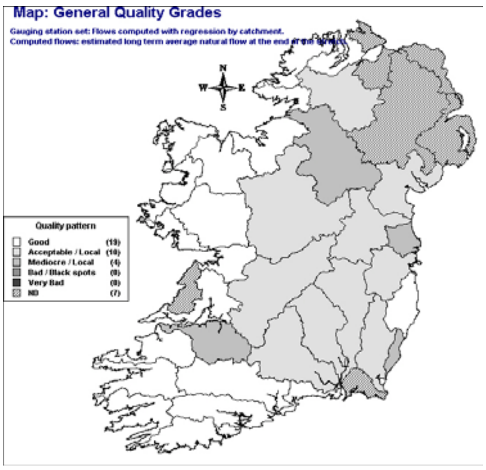




The five maps above (from the 2002 French State of the Environment report) show the aggregated **RQGI**, all rivers (left), for the 55 reporting catchments, and the RQGI broken down in four size classes (left, right, up, down; largest, large, medium and small rivers)

The right bottom map represents the changes in water index in England and Wales, per catchment, with respect to phosphorus contamination of waters. The range of colours indicate improvement (blue) or degradation (red).





The other figure, on the right, shows the pattern of river quality in the Republic of Ireland, considering biological quality. The patterns suggest that local pollutions are responsible for the observed mismatches with good quality objectives. This can facilitate orientation of assessments and further action plans.

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Title: No: 12

WATER QUALITY MODELLING IN TEJO RIVER (Portugal)

Type of impact:

Analysis of water quality in the main river

Type of pressure:

Water quality in tributaries and loads from point sources

Type of analysis or tool:

The water quality model adopted for the simulation of the river was the Enhanced Stream Water Quality Model QUAL2E model (EPA, 1987).

Information and data requirements

Information and data on flows and on water quality were obtained on the Networks Monitoring. Loads from point sources (urban wastewater and main industries).

Brief description including figures

Methodology and Application

Tejo river basin is one of the largest in the Iberian Peninsula, with an area of about 80 629 km^2, being 55 769 km^2 (69%) in Spain, and 24 860 km^2 (31%) in Portugal. This river travels along 230 km in Portugal and discharges to Atlantic Ocean, after crossing Lisbon City.

In the last years the natural regime has changed and the flow from Spain has decreased significantly due to the construction of a large number of reservoirs and the increase of water demands. As a consequence, the water quality characteristics, within the basin, have also been significantly changed during the recent past due to anthropogenic actions.

Concerning the production of drinking water, the greater Lisbon area and several municipalities in the lower Tejo region, with a population of more than two million people, are supplied by several surface water abstractions. Due to great social, ecological and economic importance, the Tejo watershed has been studied with the purpose of identifying the relevant point and non-point pollution sources, to characterise water quality and adequacy to the observed and proposed uses. With all this information available it's possible to apply and calibrate models to simulate the evolution of water quality, for different scenarios of hydrologic conditions and pollutant loads.

Several water quality models were evaluated for suitability to the Tejo River. The water quality model adopted for the simulation of the river was QUAL2E model (EPA, 1987), which was considered to be more adequate to the program goal and the available data.

The river reach studied is between the boundary section, used as headwater, and the beginning of the estuary (last element in the system), with a length of 150 km. A computational element length of 2 km was chosen as sufficient to describe spatial detail along the river. In the river reach under study there are two dams, Fratel and Belver. Due to their hydraulic characteristics and operational conditions they were treated as a stream segment were the flow is unidimensional and is not affected by stratification. Phisiographic data was based on transversal profiles surveyed in the 1970's. Information and data on flows were obtained on the Freshwater Network Monitoring. Figure 1 shows the reaches and computational elements considered. Also illustrated are the 25 point loads considered and localisation of dams.

Figure 1 – Reaches, computational elements and 25 point loads considered, and localisation of the dams.

Currently, there are 50 water quality sampling stations in the Tejo watershed, where sampling is done monthly. The Tejo river model input used observations of water quality at stations located at the national border (headwater in the model) and at the last element in the system (beginning of the estuary). QUAL2E can incorporate fixed downstream constituent concentrations into the algorithm. When no direct observations were available, inflows and associated concentrations of water quality were estimated. Estimate values of these flows were made by hydrologic balances of river segments, based on the locations of sampling stations. Nutrient concentrations in flows entering the river were estimated with the available data.

The Tejo River model calibration utilised prototype observations of water quality for nine sampling stations. Annual means and summer means were selected to represent two hydrologic and climatologic regimes. Summertime characteristics with low flow conditions were simulated, permitting to analyse the behaviour of the river in the worst conditions of wastewater discharge with increase of pollutant loads to the system. Several calibration data sets corresponding to specific sampling data in summertime were selected to provide a variety of hydrologic conditions.

Results

A geometric representation of the hydraulic characteristics of the stream channel was used. Stream velocities and flows determined by the model were found to be suitable to represent the Tejo River. The two dams present in the first 50 km of the river are responsible for the low velocities observed.

Figures 2 and 3 illustrate the results of the application of QUAL2E to the Tejo River for summer conditions. The results are analysed taking in account the field observations, the major uses of the river and compared to water quality objectives set by national and international legislation. Calibration sequence for quality variables was temperature, dissolved oxygen, BOD, phosphates, nitrates and ammonia. Results of calibration were generally good, except for ammonia.

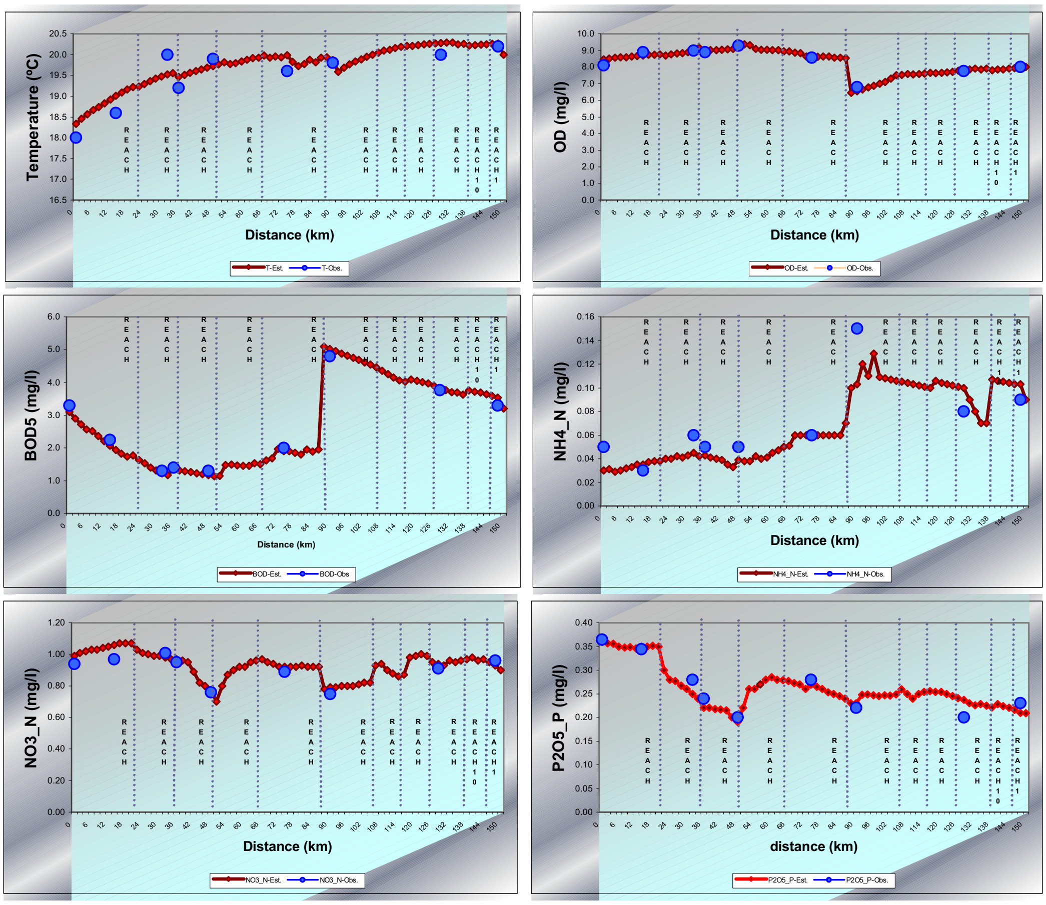

Figure 2 - Comparison between QUAL2E output and observed values in the sampling stations of Tejo.

The profiles obtained for the parameters (Figure 3) represent the actual impact on water quality from the different sources of pollution that affects the Tejo River. The big reservoirs in Spain have some effect by reducing BOD, but in terms of nutrients high amounts continue to reach to the border. This will affect the two reservoirs in the national part that have already problems of eutrophication. On other hand, in the national basin there are some problems, especially the impact of the paper industry and Zêzere plus Nabão Rivers, which have a representative flow. Also two important tributaries, Almonda and Alviela Rivers represent a significant contribution of pollution that affects the Tejo River more downstream.

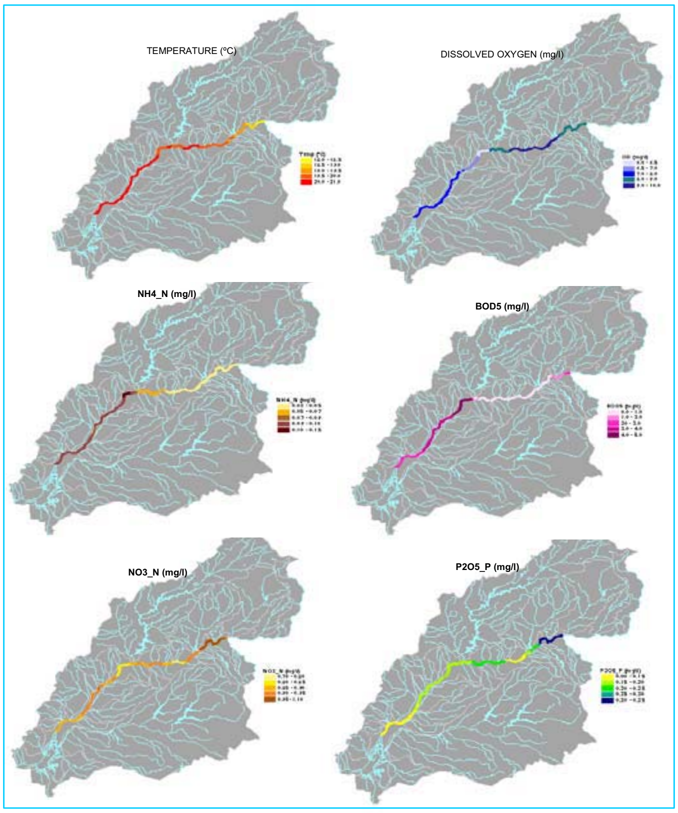

Figure 3 - Profiles of QUAL2E using GIS maps.

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Title: **No: 13**

CRITERIA FOR THE INVESTIGATION OF SIGNIFICANT PRESSURES AND EVALUATION OF THEIR IMPACTS FOR PURPOSE OF REPORTING TO THE EU COMMISSION; - STRATEGY PAPER OF THE WORKING GROUP OF THE GERMAN STATES ON WATER (LAWA) – (Germany)

Type of impact:

Status and change of water quality (eutrophic and saprobic status, toxicity, rewarming), changes of habitat, changes of the hydrological regime

Type of pressure:

Point sources, diffuse sources, water flow regulation, morphological alterations, heat input

Type of analysis or tool:

Analysis of existing data on emissions and on the state of a water body, threshold values or balance models for diffuse sources; analysis of impacts based on quality objectives and threshold values, knowledge of experts

Information and data requirements

Data on emissions (communal waste water discharges, industrial waste water discharges) data on land use, data of the state of water body (physicochemical measurements, data on quality of waters and structures of the water body), data about water abstraction

Brief description including figures

For the purpose of investigating significant pressures and evaluating their impacts, a strategy paper was compiled in Germany by the State Working Group on Water (LAWA). The objective is an efficient procedure, agreed on by all states, for compiling the inventory in accordance with Annex II of the Water Framework Directive (WFD) by the end of 2004. For the first description, the strategy paper is oriented on the availability of meaningful and stable data. Should a more extensive description be required, more detailed data will be compiled and, if necessary, collected locally.

Table 1: Data to be collected for different pressures

PRESSURES	**Criteria**
Point sources	
• Public sewage-treatment plants >2000 PE (derived from Urban Wastewater Treatment Directive)	Annual volume of water discharge Population (P) and population equivalents (PE) Substance loads according to Annex I of the German Wastewater Directive Annual loads of priority substances, substances of the quality objective directive, and river basin-specific substances, insofar as these substances are limited by water directives
• Industrial direct discharge	Statement of systems according to IPPC Directive = pollutants according to EPER Annual loads of plants with obligation to report according to IPPC Directive: consideration of the particular size threshold for the annual load of 26 substances (cf. Table 1: Size thresholds; EPER) Annual loads of priority substances, substances of the quality objective directive, and river basin-specific substances, insofar as these substances are limited by water directives Food industry facilities >4000 EP
• Storm water / combined wastewater discharges	Discharge of wastewater from an urban area >10 km^2
• Discharges with heat load	Discharges with heat load >10 MW
• Salt discharges	Discharges >1 kg/s chloride
Diffuse sources	Not yet finally defined, coordination with criteria for endangerment of groundwater bodies
Water abstraction	Abstraction without recirculation >50 l/s
Water flow regulation	Procedure for small/medium-sized water bodies: o Parameter "anthropogenic barriers" (Stream habitat survey): ≥6 o Parameter "backwater" = 7 or according to general procedure: o Impassable anthropogenic barriers and backwater
Hydromorphological alterations	Based on the results of river habitat survey or similar investigations: "Water-body bed dynamics" with structural classes 6 and 7

For the purpose of compiling the significant pressures, the WFD indicates which substances and groups of substances are to be considered. In some cases, data that have already been compiled on the basis of other directives (e.g. communal wastewater directives) can be used. Table 1 illustrates what information is to be gathered for the various pressures.

Supplementary to the emissions data, data on the state of a water body available from environmental surveillance should be examined. Primarily data on the state of a water body will be considered to evaluate the impacts of the pressures and will be judged according to quality objectives and aggregation criteria. As a rule in Germany these data are present in the spatial density adjusted for the quality aspects and the site of the impact. If these are insufficient, an assessment or consideration of a model based on established pressures is necessary. An estimation of probability that the good ecological or chemical conditions will not be achieved within a period of observation will be made on the basis of the criteria presented in Table 2.

Table 2: Information necessary for the assessment of impacts

Indicator	**Threshold values**
Saprobic status	30% of stream network > national biological quality level (here: biological quality level II; indicator macrozoobenthos)
Trophic status	➢ 30% of stream network > national quality level (here: trophic class > II, indicator: chlorophyll a, pH, O2) ➢ also in discussion, but not yet finally defined: assessment by nutrient content/load of the rivers
Physicochemical substances	Exceeding existing quality objectives or quality criteria of EU directive 76/464/EEC and knowledge about entries of priority substances
Warming	According to the EU Fish-Life Directive: - max. annual temperature: >21.5°C (salmonid water body) >28°C (cyprinid water body) - max. winter temperature: >10°C (salmonid water body) >10°C (cyprinid water body) - max. warming up: 1.5 K (salmonid water body) 3.0 K (cyprinid water body)
Salinisation	Median: CI > 400 mg/l
Morphology	- River habitat survey -- overview method: More than 30% of the river distances within the management unit are surveyed with structural quality classes 6 or 7 for the compartment "river bed". - Impairment of river continuity >30% of stream network

The utilisation of the strategy paper has already been tested in the pilot projects "Große Aue" and "Middle-Rhine". The strategy paper will be continued from case to case in consideration of new developments.

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Title: **No: 14**

CASE STUDY "GROßE AUE" – DEVELOPMENT OF A RIVER BASIN MANAGEMENT PLAN FOR THE CATCHMENT „GROßE AUE" WITHIN THE RIVER BASIN DISTRICT WESER

Type of pressure:

Urban discharges, land use, water flow regulation

Type of impact:

Urban discharges, land use: Increasing loads, alteration in saprobic status

Water flow regulation: Morphological alterations, migration barriers

Type of or tool:

Urban discharges, land use: Monitoring of all sewage treatment plants and combined stormwater discharges, evaluation of data from CORINE landcover. Combined assessment of point sources and diffuse sources, for nitrogen and phosphor with a mass balanced model as statistic tool (MOBINEG).

Water flow regulation: Two ways of river habitat survey

Information and data requirements:
Urban discharges: Sources of Data: StUA (environmental authority) Minden (North Rhine-Westphalia); Bezirksregierung (regional gouvernment) Hannover (Lower Saxony):

- Self-control with data-sets depending on the size of sewage water treatment plants;
- Officially controlled 4 times a year.

Land use: Sources of Data: Federal Statistical Agency, basing on Dates of:

- Landwirtschaftskammer (agricultural administration) North Rhine-Westphalia;
- Landwirtschaftskammer (agricultural administration) Lower Saxony.

Water flow regulation: River habitat survey

- River habitat survey North Rhine-Westphalia: Operational detailed assessment; basing on „on-location" knowledge; Scale: 100 m
- River habitat survey Lower Saxony: Overview method; basing on maps, aerial view, collected data; Scale: 1000 m.

Brief description including figures

Aim of these pilot-project of the implementation of the Water Framework Directive was:

- to investigate the driving forces and pressures in the catchment area of the "Große Aue" (northern German low-lands) for surface and ground water bodies;
- to exemplify a programme of measures for achieving the good ecological status;
- to compile an orientation guide for provision, organisation and interpretation of data;

As main pressures, urban discharges (point sources), land use (diffuse sources) and water flow regulation were identified. To assess the influences of point- and diffuse sources on the input of the nutrients nitrogen and phosphor into surface waters a combined mass balanced model, MOBINEG, was used. With this tool effects of sources can be displayed clearly:

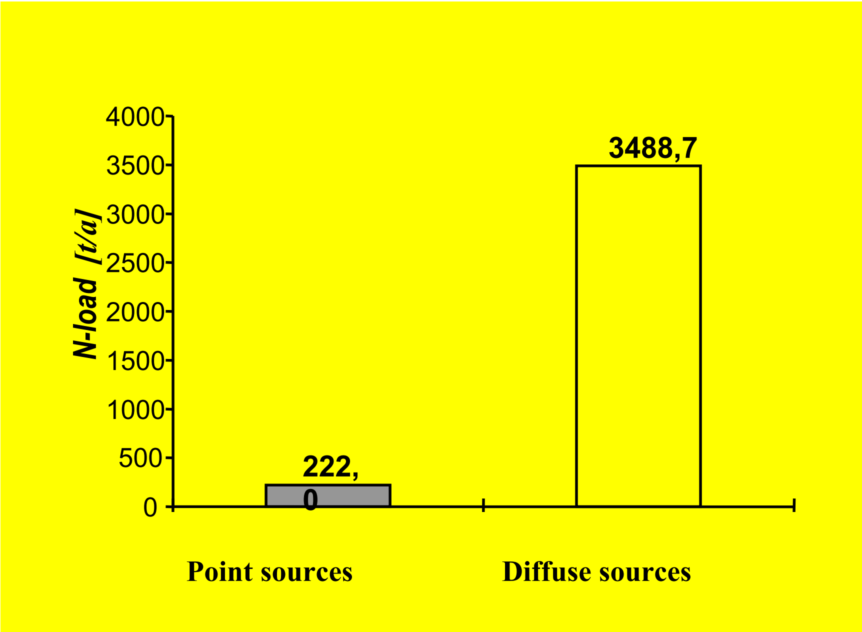


Fig. 1:
N-loads from point- and diffuse sources in the catchment area of the river „Große Aue"

Referring to the diffuse discharges the cultivated areas are the main sources. Nearly 90 % of the diffuse nitrogen discharges to the surface water bodies come from cultivated areas.

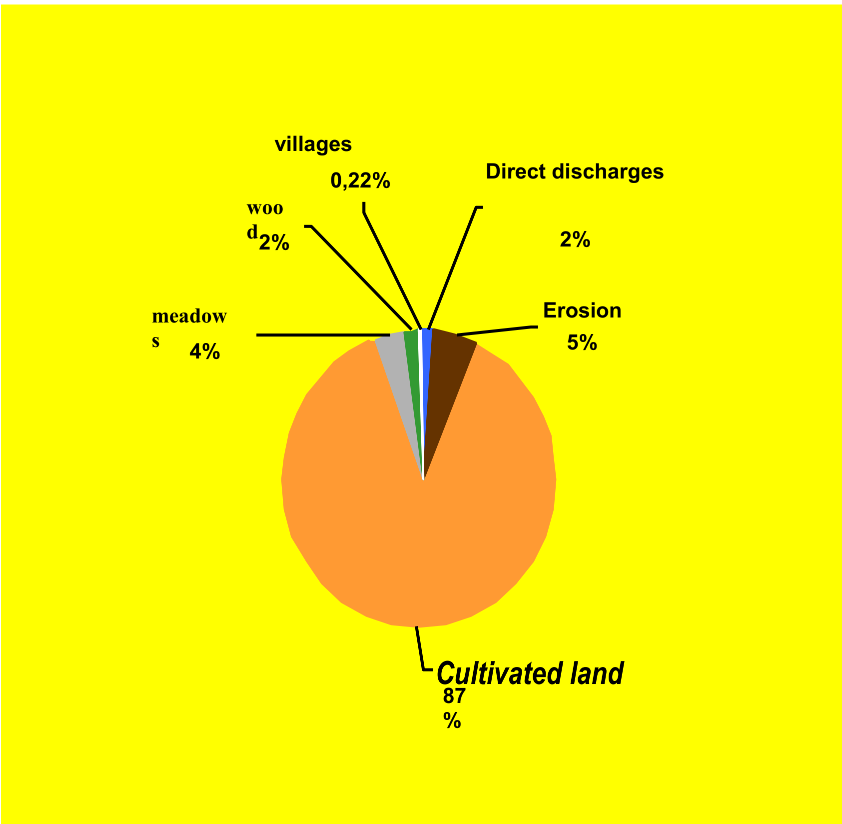
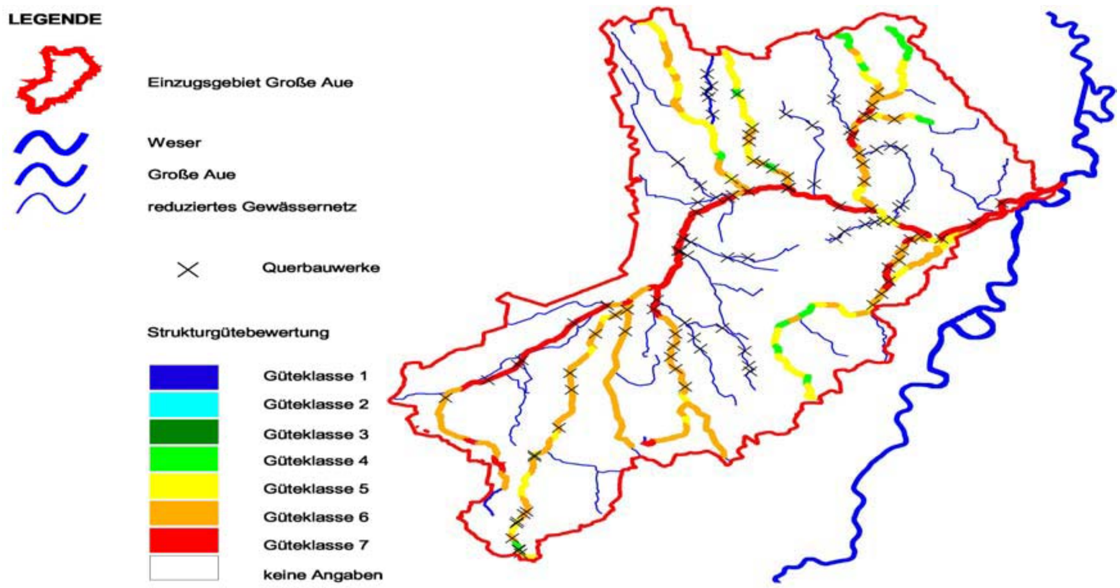


Fig. 2:
Percentage of named diffuse sources concerning the N-loads in the catchment-area of the river „Große Aue"

Within the scope of the case study „Große Aue“ investigations on the flora and fauna of the river „Große Aue“ and several studies have been carried out. The present composition of species shows some lack in indigenous species and migratory fish, which result from impairment of river continuity as well as hydromorphological alterations (flow regulation, flood protection). The results of the river habitat survey are shown in the form of a map which also includes information about the migration barriers:

Fig. 3: Results of the river habitat survey



In Germany for the reason of investigating significant pressures and assessing their impacts the State Working Group on Water (LAWA) developed a viable strategy paper. The objective is an efficient procedure, agreed on by all states, for compiling the inventory in accordance with Annex II of the WFD by the end of 2004. For the first description, the strategy paper is oriented on the availability of meaningful and robust data. Primarily data of the state of a water body (saprobic status, trophic status, physico-chemical substances, structure of a waterbody) will be used to assess the impacts of the pressures and will be judged according to quality objectives and aggregation criteria. The utilisation of the strategy paper has already been tested in the pilot project “Große Aue”.

References

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http://www.bezirksregierung-hannover.de/0,,C40033_N5205_L20,00.html

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Title: **No: 15**

PILOT-PROJECT MIDDLE-RHINE: DEVELOPMENT OF RIVER BASIN MANAGEMENT PLAN

Type of impact:

Habitat alterations, modifications of the hydrological regime

Type of pressure:

Diffuse sources, water flow regulation, morphological alterations

Type of analysis or tool:

Analysis of available data of emission and of the state of a water body, balancing models, impact analysis basing on quality objectives and threshold values, expert knowledge

Information and data requirements:

Data of the state of a water body (physico-chemical measurements, water quality and structure of the water body), data about water abstraction, structural state of waters

Brief description including figures:

For purpose of surveying the significant pressures and assessing their impacts the LAWA-group in Germany developed a viable Strategy Paper (see previous example of current practice). With the "Middle-Rhine-Project" of the German federal states Hesse and Rhineland-Palatinate an example, following the LAWA-criteria, concerning the inventory taking according to ANNEX II of the WFD until the end of 2004, is given. Figure 1 shows the surveyed catchment area of the project:

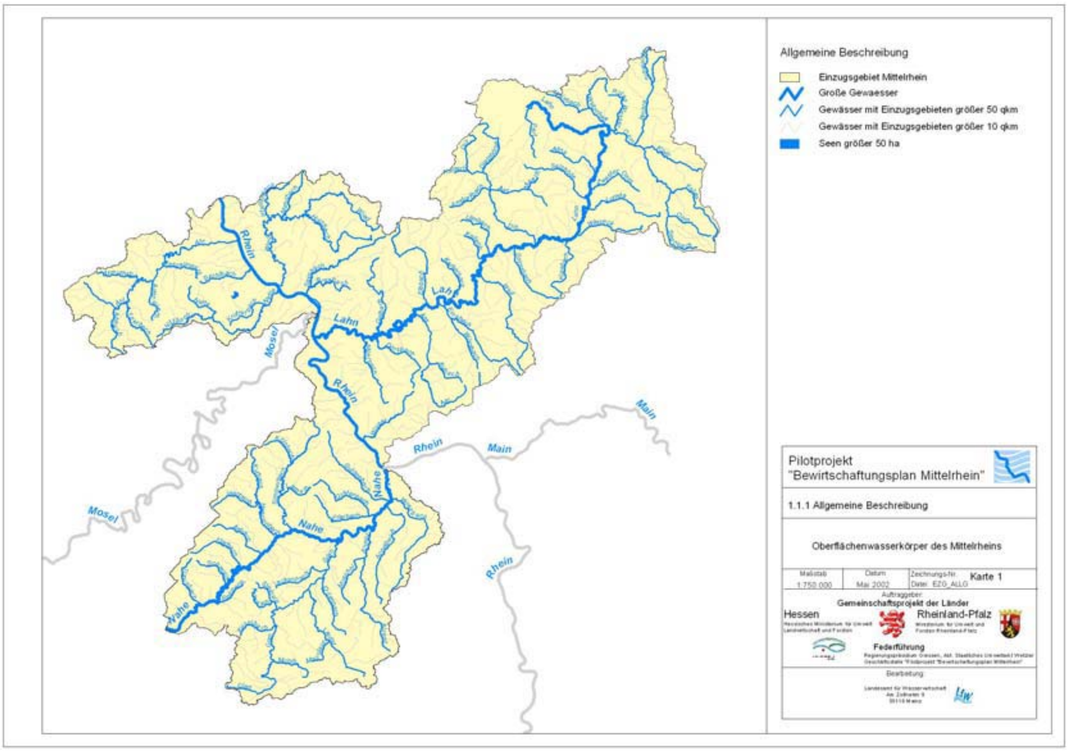

Figure 1: Catchment area of the "Middle-Rhine"

In the project some LAWA-criteria and their combinations concerning point and diffuse sources have been tested on the base of 10 km²-units. As an example the diffuse sources:

- Cultivated land > 50% (current value is still discussed);
- Urban land > 15%;
- Special crop land > 5%;
- Cultivated land > 50% and urban land > 15%;
- Cultivated land > 50% and special crop land > 5%;
- Special crop land > 5% and urban land > 15%;

have been tested. Figure 2 shows the significant areas:

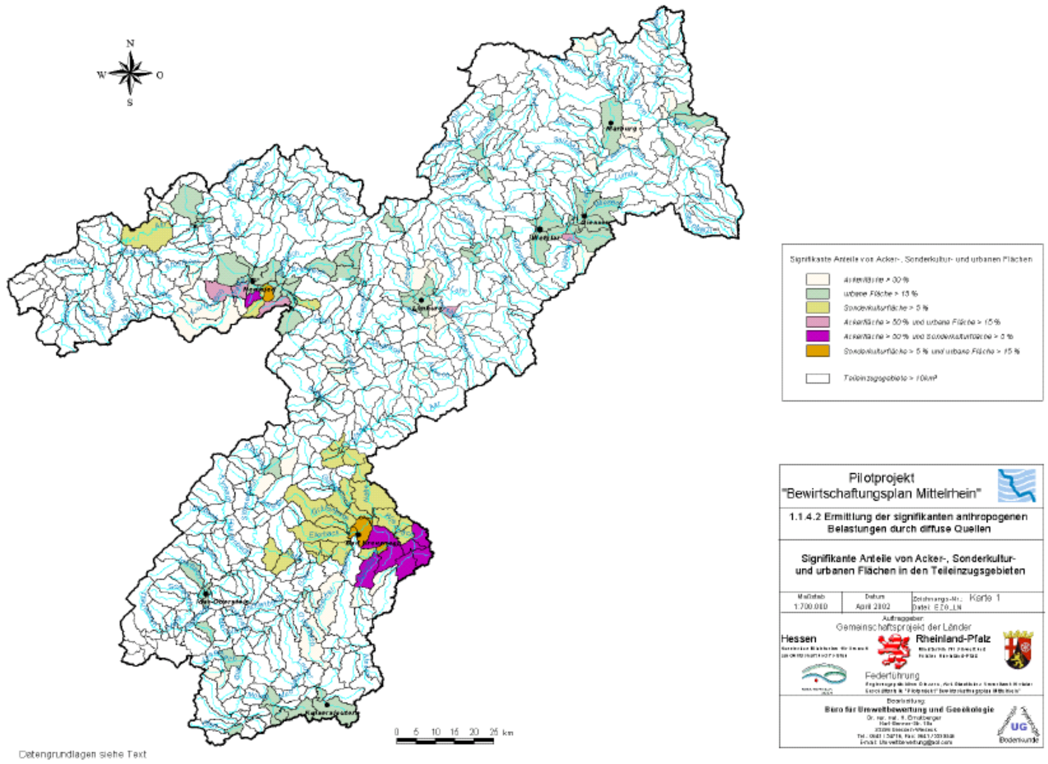

Figure 2: Significant areas concerning diffuse sources in the catchment area of the "Middle-Rhine"

In addition to the emission data, other available data on the state of a water body from environmental surveillance have been considered. For the assessment of the impacts, primary data on the state of a water body have been used. Concerning morphology the former LAWA-criteria regarding the of surveyed river distances (Stream habitat survey - method for little and medium size waters in Germany; LAWA (2000)) with:

- Structural quality class >4 in free landscape (has been adapted from 3 to 4)
- Structural quality class >5 in urban areas

have been tested.

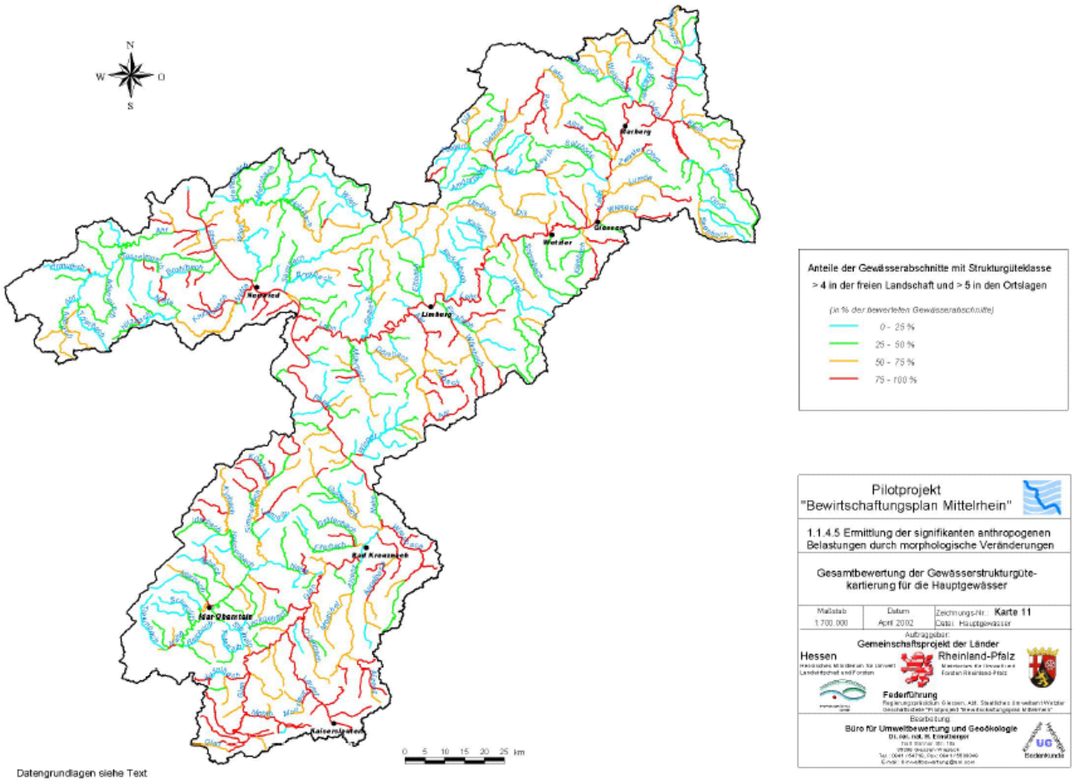

Figure 3: Amount of surveyed river distances with structural quality class >4 in free landscape or structural quality class >5 in urban areas in the catchment area of the "Middle-Rhine"

References

Pilot-Project „River Basin Management Middle-Rhine":Common Project of the german federal states Hesse and Rhineland-Palatinate, report (draft).

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Language: german

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