JRC Scientific and Technical Reports

Pilot River Basin Activity Report Phase II: 2005-2006

Water Framework Directive implementation pilot activities
Key challenges and recommendations from the Pilot River Basins

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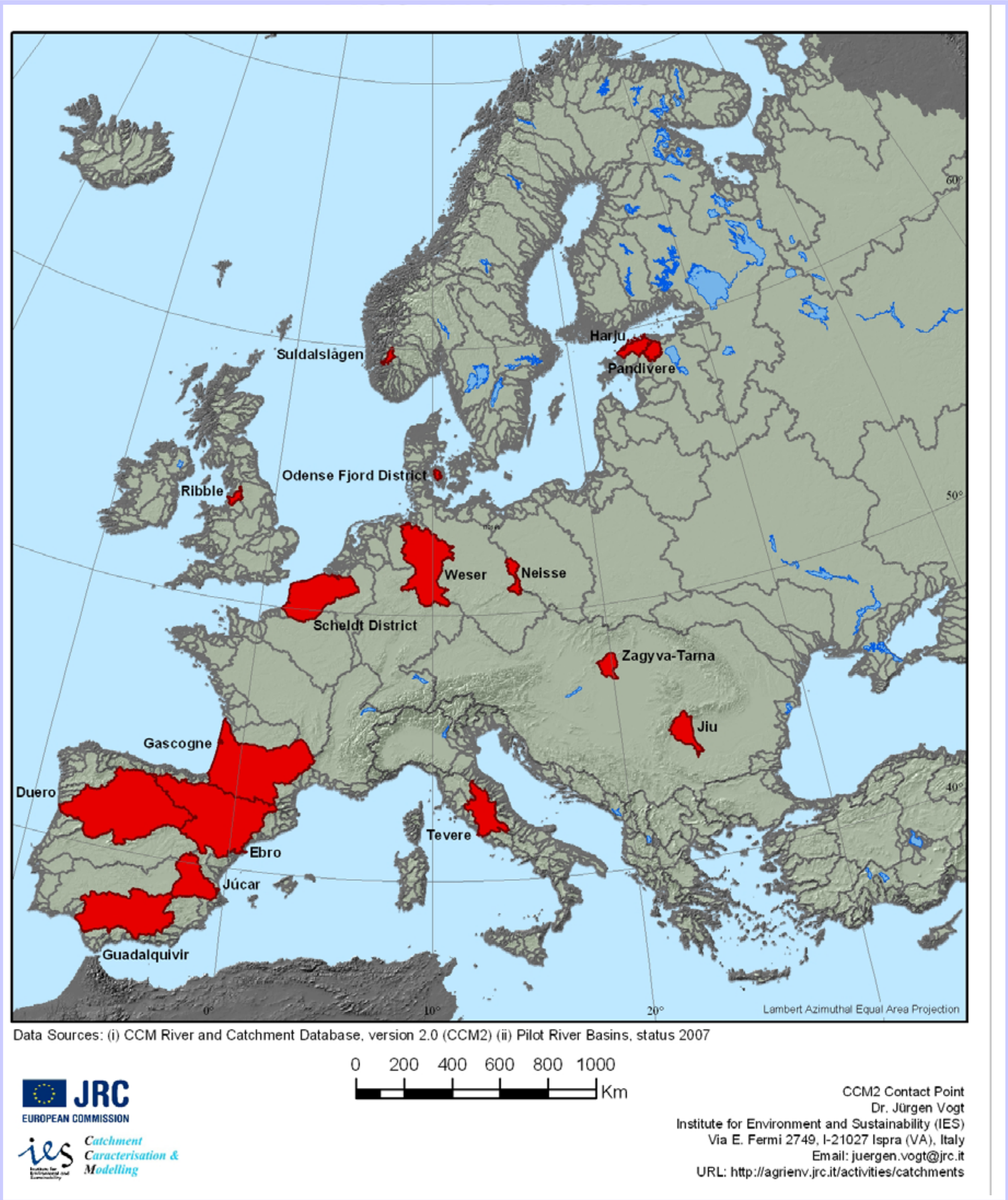

This document has been jointly prepared by the **Joint Research Centre** and the **Directorate General Environment of the European Commission**, based on the work carried out by participants in the exercise:

• Weser (DE)	• Duero (ES)	• Júcar (ES)	• Suldal (NO)
• Odense (DK)	• Ebro (ES)	• Gascogne (FR)	• Jiu (RO)
• Harju (EE)	• Guadalquivir (ES)	• Scheldt (FR/BE/NL)	• Ribble (UK)
• Pandivere (EE)	• Neisse(DE)	• Tevere (IT)	• Zagyva-Tarna (HU)

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ABBREVIATIONS:

AEM: Agro-environmental measures

AMWB: Artificially Modified Water Body

AWB: Artificial Water Body

BOD: Biological Oxygen Demand

BQE: Biological Quality Element

BRIDGE: Project acronym: "Background criteria for the identification of groundwater thresholds"

CAP: Common Agricultural Policy

CEA: Cost-effectiveness analysis

CIS: Common Implementation Strategy

CSO: combined sewer overflow

CTP: Collaborative Technical Platform

DDT: Dichloro-Diphenyl-Trichloroethane

DKK: Danish Krone (currency)

EAFRD: European Agricultural Fund for Rural Development

EC GIG: Eastern Continental GIG

ECOSTAT: Ecoological Status Working group (WG A)

EEB: European Environmental Bureau

EEK: Estonian kroon (currency)

EQR: Ecological Quality Ratio

GD: Guidance Document

GDR: German Democratic Republic

GEP: Good Ecological Potential

GIG: Geographic Intercalibration Group

GIS: Geographic Information Systems

H-G-M-P-B: High, Good, Moderate, Poor, Bad

HCH: Hexachlorocyclohexane

HEAT: Helcom Eutrophication Assessment Tool

HELCOM: Helsinki Commission

HELCOM EUTRO: Development of tools for a thematic europhication assessment

HMWB: Heavily Modified Water Body

HTTP: Hypertext Transfer Protocol

IC: Intercalibration

ICMi: Intercalibration Common Metric index

ICPDR: International Commission for the Protection of the River Danube

IES: Institute for Environment and Sustainability

INSPIRE: Infrastructure for Spatial Information in Europe

IRR: Internal Rate of Return

JRC: Joint Research Centre

LAS: linear alkylbenzene sulphonate

LAWA: German Working Group of the Federal States on water issues

LF: Low Flow

MM: Mitigation measures

N: Nitrogen

NGO: non-governmental organisation

NMVOC: non-methane volatile organic compounds

NOVANA: National Monitoring and Assessments Programme for the Aquatic and Terrestrial Environments, Denmark.

NPV: Net Present Value

NWB: Natural Water Bodies

OGC: Open Geospatial Consortium

OSPAR: Oslo Paris Convention

OSPAR COMM: OSPAR Commission

P: Phosphorous

PAH: Polycyclic aromatic hydrocarbons

PC: physico-chemical group

POM: Programme of Measures

PRB: Pilot River Basins

QE: Quality Element

RBD: River Basin District

RBMP: River Basin Management Plan

RD: Rural Development

RefCon: Reference Conditions

RWER: Rural, Waters and Ecosystems Resources

SAV: submerged aquatic vegetation

SEA: Strategic environmental assessment

SEA-NINE: antifouling agent for commercial ship-building paints

SDI: Spatial Data Infrastructure

TBT: tributyl tin

TCA: trichloroacetic acid

UHR: Hydrographic Unit of Reference

UTM30: Universal Transverse Mercator projection system, zone 30

WFD: Water Framework Directive (Directive 2000/60/EC)

WISE: Water Information System for Europe (water.europa.eu)

WWTP: Waste Water Treatment Plant

PART I
SUMMARY REPORT

I.1. GENERAL INTRODUCTION: PHASE II OF THE PILOT RIVER BASIN ACTIVITY

Building on the successful work of the first phase (2002-2004), the Pilot River Basins (PRBs) have continued to work closely also in the second phase (2005-2006) within the Common Implementation Strategy of the Water Framework Directive (WFD).

The main objective of Phase I was to test and report on coherence amongst the different Guidance Documents (GDs), leading to the long-term development of River Basin Management Plans and preparation of Programs of Measures. The main deliverables in Phase I were: the PRB Outcome Report, on the testing of WFD Guidance Documents[1]; early Article 5 reports produced by some PRBs; a number of thematic PRB workshops on the topics such as: "Groundwater", "Water body delineation", "Economy", "Mediterranean dimension", "Research and technology integration in support of the Water Framework Directive".

In the second phase (2005-2006), PRB activities were embedded in each of the Working Groups (WG) designated under the CIS work program 2005-2006 (see figure 1), rather than constituting a separate activity. A horizontal information exchange was also maintained among all involved PRBs (see CIS Work Program 2005-2006 for more details on WG mandates)[2].

The objectives of Phase II of the PRB exercise were:

- ✓ to provide concrete input and case studies to all CIS activities and to address questions on so-called "key areas", as identified by the respective Working Groups;
- ✓ to present examples and ideas for key elements of the WFD implementation, ahead of the deadlines required by the Directive, with particular reference to the monitoring network (deadline end of 2006) and the Pilot River Basin Management Plan (deadline end of 2009);
- ✓ to create networks and promote activities with other interested partners on subjects not (yet) identified as key areas under the Common Implementation Strategy.

The PRBs actively involved in the second phase were :

- ✓ Weser (Germany)
- ✓ Odense (Denmark)
- ✓ Harju (Estonia)
- ✓ Pandivere (Estonia)
- ✓ Duero (Spain)
- ✓ Ebro (Spain)
- ✓ Guadalquivir (Spain)
- ✓ Neisse (Germany)
- ✓ Jucar (Spain)
- ✓ Gascogne (France)
- ✓ Scheldt/L'Escaut (France, Belgium, the Netherlands)
- ✓ Zagyva-Tarna (Hungary)
- ✓ Tevere (Italy)
- ✓ Suldal (Norway)
- ✓ Jui (Romania)
- ✓ Ribble (United Kingdom)

This list shows a wide geographical distribution of river basins with different characteristics. A

[1] [EUR 21518 EN]. This document is available on CIRCA (circa.europa.eu), both in the public and in the PRB sections

[2] http://ec.europa.eu/environment/water/water-framework/objectives/implementation_en.htm

number of other PRBs[3] were also involved in the exercise but could not contribute to this report, because of a late start of activities.

The key areas are all the activities agreed in the CIS Work Program 2005-2006, including subjects dealt with by the five Working Groups and the Strategic Steering Group on "WFD and Agriculture". PRBs were not asked to address all issues raised, or to follow all activities, but rather to select amongst them on the basis of their interest and resources availability. In this context, the PRBs undertook activities on the following topics:

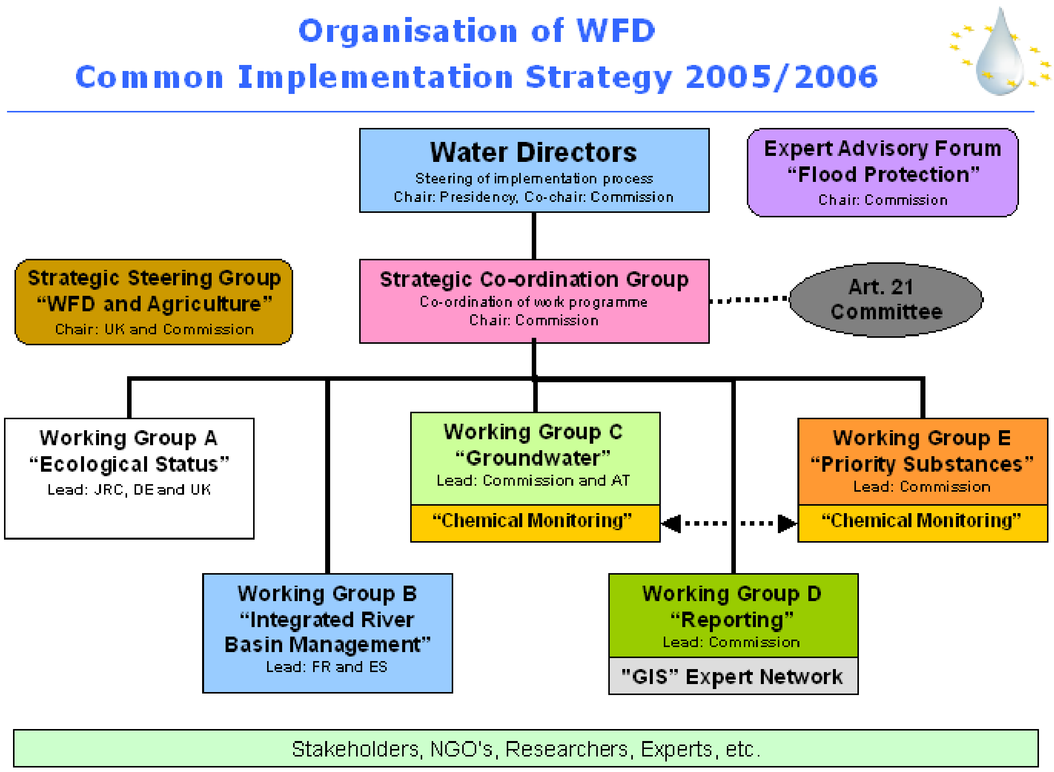

Figure 1. CIS work program 2005-2006

- River basin management planning, including international cooperation (chapter III.2)
- Hydromorphology (chapter III.3)
- Intercalibration/classification (chapter III.4)
- Cost-effectiveness analysis (chapter III.5)
- Link with research (chapter III.6)
- Priority substances and other pollutants (chapter III.7)
- Groundwater (chapter III.8)
- Reporting (chapter III.9)
- WFD and Agriculture (published as a separate report, and summarized in section IV of this volume).

Activities within each of the above-mentioned topics have been integrated with the Common Implementation activities in collaboration with the relevant working groups through: participation in meetings and reports; horizontal PRB coordination meetings; in particular, for the Strategic Steering Group "WFD and Agriculture", specific thematic workshops were organized. Most of the information material has been maintained on a dedicated website with restricted access.

[3] Cecina(IT), Krka(SL), Marne(FR), Oulujoki (FI) and Pinios (EL).

In Phase II, both PRBs continuing from Phase I and new PRBs have respectively maintained or build from new a structure of agencies and stakeholders to work on the key areas and issues chosen. The challenges were both in terms of initiating communication between people of different professional and scientific background, in finding and allocating resources (human and financial), in maintaining the efforts and motivation throughout the projects, in setting up the appropriate organization for co-ordinating and controlling the development of the project.

This report comprises of four sections: part 1 is the introductory section, providing the background and rationale; part 2 includes the descriptions of all PRBs participating to the activities described in part 3; part 4 provides a summary of the activities and findings of PRBs collaborating with the Strategic Steering Group “WFD and Agriculture”.

This report and the full PRB group report on agriculture titled "Experiences in Analysis of Pressures and Impacts from Agriculture on Water Resources and Developing a Related Programme of Measures" are available at:

http://ec.europa.eu/environment/water/water-framework/prbs.htm.

I.2. SUMMARY OF MAIN FINDINGS

On the river basin management plan. All PRBs emphasized the importance of starting early with the preparation of the River Basin Management Plan; the tight timing set forth in the WFD imposed the presence of a clearly defined cooperation structure within each PRB. The importance of getting to know each other within these cooperation structures was also mentioned, both on the national and the international level. Although the importance of cooperation was acknowledged, several PRBs experienced it as a time- and resource-consuming process. Hence the importance of allocating enough resources for this process was stressed, although these resources are not easily available. Development of integrated management strategies and cost-effective analyses are vital focus points in the process, to ensure as efficient and economically optimal planning as possible. As a final remark, it was noted that it often seems easier to reach a consensus in technical discussions between experts than in policy discussions between policymakers, because at that point political and economic interests come into play.

On hydromorphology. Morphology and river continuity have been identified as the major topics for implementing the WFD in the river basins. For example, in the Suldal River Basin hydromorphological pressures are caused by hydropower, and mitigation measures are mainly targeting this issue. Rivers and lakes that are subjected to the hydromorphological changes have been provisionally designated as HMWB (almost 50% of all water bodies in the river basin). A draft methodology developed in Norway provides criteria to establish environmental goals for the HMWB, considering the Good Ecological Potential.

In the Weser River Basin strategies for mitigating impacts from barriers and degraded hydromorphology by integration of ecological demands of migratory fish species and the actual status of river continuity on different levels are developed. On the river basin level measures focus on the improvement of important migration routes whereas at regional or local level the enhancement of habitat structure and quality is of major importance. Moreover, the regional projects provide examples involving stakeholders and the public. In order to find cost effective solutions, the concept will support the selection of priority areas and measures.

Both approaches are aimed at establishing environmental objectives, in the Suldal PRB the objectives for HMWB are looked at, in the Weser PRB objectives with respect to continuity and migratory fish species are considered. As a result feasible and cost effective measures that will improve the status in the river basins will be identified.

In the case of Neisse, a theoretical approach has been designed but not tested, due to late start of activities.

On intercalibration and classification. The intercalibration exercise aimed at creating agreement between all Member States on the good status class boundaries, developing methods and tools for assessment and classification of designated water bodies in order to achieve the objectives of the Water Framework Directive (WFD).

The Odense PRB presents the results of the national Danish intercalibration exercise testing the HELCOM Eutrophication Assessment Tool (HEAT) on the Odense river and 13 other marine areas. For the Odense PRB, the following specific conclusions can be drawn.

Determination of reference conditions should be based as much as possible on historical data and numerical modelling and as little as possible on expert judgement (the latter comprised only 4% in this exercise). It is recommended to use as many indicators as possible within each quality element to make the classification robust and lessen any misclassification. Weighting between indicators should be applied simply because all available information should be used (e.g. distinguishing 'strong' indicators), although the actual outcome in this particular exercise was relatively unaffected.

Definitions in the WFD should be translated into numeric class boundaries using a scientific approach (as for the setting of RefCon).

The outcome of the classification by HEAT is identical to earlier assessments of Odense Fjord and other Danish coastal areas especially when the more stringent scenarios are applied (15 or 25% acceptable deviation from RefCon). HEAT can be modified into a tool that both can assess 'ecological status' sensu WFD and 'conservation status' sensu the Habitats Directive (can also potentially address the Marine Strategy). Joint implementation of all directives can be strengthened by developing assessment tools, like HEAT, that will seek convergence of the different assessment procedures.

The Jiu PRB contributed with official and supplementary sites and data through the Eastern Continental Geographic Intercalibration Group (EC GIG). The following conclusions can be drawn for the Jiu PRB:

- the biological analyses need a common assessment and a unique methodology (harmonization);
- the chemical methods must be improved – especially for the priority hazardous substances;
- final intercalibration can only be done for all EC GIG countries when WFD-compliant methods are available, but preliminary intercalibration is currently performed with non WFD compliant methods.

Currently, further supplementary data for reference sites/best available sites are collected in order to improve the intercalibration exercise. Information on best available sites for some common type is collected to enable the intercalibration of large rivers. For lowland streams and large rivers the reference sites are almost impossible to find, the main cause being the existence of anthropogenic pressures.

Regarding the continuation of the intercalibration exercise within the Jiu PRB through the EC GIG, the following issues will be addressed: i) completing the data through the continuation of the monitoring process in the intercalibration and reference conditions/best available sites; ii) using other BQEs (phytoplankton, macrophytes and fish fauna) for the continuation of the IC exercise; iii) using only WFD compliant sampling/assessment methods.

On cost-effectiveness analysis. This instrument has been tested by various river basins following a number of approaches. Aside from the Weser river basin, displaying a clearly defined problem linked to industrial point and diffuse discharge of Cl, the main problem remains the excessive discharge of N and P from point and diffuse source. While a few countries had already in place some sort of CEA, or CBA, for evaluation of mitigation measures, others had to start the process entirely. In all cases an evaluation on the types of measures has been made, giving priority to technical/structural measures (buffer strips, controlled use of fertilizers, etc.), and resorting to economic and other measures only when there was a clear cost effectiveness indication. The approaches adopted vary from simulation models to determination of unit costs of each measure. Administratively, different approaches have been proposed: scenario analysis and CEA can be run at the lowest administrative level possible or developed at regional scale. Both approaches seem to give good results, depending on the administrative and organizational structure in place in each country. It must be emphasized that for some of the participants the CEA process had a late start, and will be completed in 2007, so that final results might differ from what illustrated in the present report.

On links with research. At the Adour-Garonne RBD scale, the science-society-policy interface called ECOBAG (for environment, ecology and economy of the Adour-Garonne RBD) was adopted. The method has been applied to tackle the questions related to agriculture and WFD implement. The result of the triple helix approach is the demonstration project "Concert'Eau", proposing a collaborative technological platform (CTP), gathering scientists from large range of disciplines, decision makers, water managers and, cooperatives and agriculture organizations. The scope of the project is to deliver mitigation measures (MM) and a program of actions (PoA) to mitigate impacts of agriculture activity on water resource and associated aquatic ecosystems of the Gascogne Rivers PRB.

On reducing risks of chemical pollution. The available data are rarely sufficient to enable assessment of compliance with the environmental objectives for water bodies as regards hazardous substances. While the monitoring should be designed to meet the needs, it is the Fyn County’s (Odense) opinion that there is a general need to increase the analysis frequency in order to comply with the WFD provisions regarding sampling frequency for hazardous substances, including priority hazardous substances. At the same time it will be necessary to expand the station network to include more localities in the monitoring program for hazardous substances. Whether the relevant substances are included in the monitoring program should be regularly evaluated, among other things on the basis of activities in the river basin, the status of the water bodies and screening investigations.

There is a need for clear guidelines on how compliance with the environmental objective for the water bodies is to be assessed as regards hazardous substances. The quality standards stipulated in the proposal of 17 July 2006 for the new directive would seem to provide the necessary basis for establishing such guidelines in the national legislation.

The investigations in Odense Fjord show that the effects of pollution with hazardous substances can often be seen in the biota and sediment before they can be detected in the individual sources of pollution. The discharge of low concentrations close to or below the limit of detection but in large volumes of water can input large amounts of hazardous substances that accumulate in the biota and sediment. There is therefore a marked need to establish special quality standards for biota and sediment for selected substances – just as the proposal for the new directive leads up to.

With some groups of substances the quality standards for water bodies are lower than the limit of detection provided by the analysis laboratories. When assessing and establishing quality standards for water bodies, efforts should therefore be made to ensure that the analysis techniques for the substances in question are developed and improved.

When issuing discharge permits for hazardous substances in the catchment area it has not previously been necessary to designate a transitional area around the discharge in which the quality standards may be exceeded. Through effective treatment and the use of the best available technology it has been possible to bring the discharges into line with the applicable quality standards for water bodies.

In order to be able to realize the WFD environmental objective regarding the phasing-out of priority hazardous substances it is necessary to chart the sources and transport pathways taken by hazardous substances to the aquatic environment, just as it is necessary to chart the occurrence and extent of hazardous substances in the aquatic environment in order to be able to initiate the planning of programs of measures to protect the water bodies against further pressure from the substances.

On groundwater. The Tevere PRB has participated in this activity, and reporting on the difficulty of identifying aquifer typology in a complex hydrogeological background as the one underlying the Tevere river basin. The prevailing conceptual model in reference work from WG C regards aquifers in large alluvial plains. This required an adjustment of the proposed methodologies to the aquifers that were identified and which are often subject to minor anthropogenic impacts but nevertheless require a high level of protection because they represent strategic drinking water resources. Further spin in the activity has been provided by participation to the BRIDGE project under the 6^{th} FP.

On reporting. Spanish activities on reporting aimed to implement a framework project with the goal of developing the necessary mechanisms and tools to perform the reporting according to the implementation plan for WISE. The two river basins have their own peculiarities; the Duero river basin is an international one, shared by Portugal and Spain, whereas the Ebro river basin shows a complex administrative situation, where it is necessary to coordinate the activity in a territory shared by nine autonomous regions. A new information system and new features were implemented during the first phase:

- ✓ Regarding WFD-Ebro, new features were implemented to generate, together with the WISE Access Tools, the files to be transferred to WISE, which included alphanumeric information (XML) and geographic information (shape files). This task involved the checking procedure of the access tools.
- ✓ WFD-Duero was developed.

The new information has a data model similar to the Ebro information system, but with different procedures and interfaces. It stores the data required for article 5 on detailed information about the river basin district.

The aim of the second phase is to build the Spatial Data Infrastructure (SDI) nodes in line with INSPIRE specifications. It is also intended for the nodes to interoperate with WISE, improving the current procedures for data loading. Reporting forced to confront with isues such as language (Catalan, Bask, and Castillan in the case of the Ebro, Portuguese and Castellan in the case of the Duero), data georeferencing, scale, etc. For the Weser the main issues were data aggregation and scale, as each scale offers a different type of definition.

I.3. KEY CONCLUSIONS AND LESSONS LEARNT

One the occasion of the drafting meeting for the preparation of this final report from Phase II of the pilot river basin activities, a discussion took place on the key lessons learnt so far on the implementation of the Water Framework Directive. The following issues were raised by individual PRBs, and although they may not necessarily reflect the consensus view, they nevertheless reflect and summarise important experiences made during the two phases of Pilot river basin activities:

- ✓ From a technical perspective, it is possible to make the practical links in the implementation chain from reference conditions to measures, via the evaluation of pressures/impacts, definition of possible measures, evaluation of target loads to achieve objectives and selection of cost-effectiveness measures. However at the political level, the process is more difficult.
- ✓ Although the process of implementation of the WFD has been in its early stages during this PRB activities, and not all aspects have been carried out perfectly, the experience is that the WFD implementation has changed very much in the way Europe's waters are managed.
- ✓ To better target the measures and to optimize the planning process, adequate monitoring program is very important, and the need for robust monitoring data is important.
- ✓ The importance of one unique and complete data systems or bases for water data has also been identified by PRBs. Although the reporting is based on aggregated or summary reports, more complex and thorough data and analysis is required at local level.
- ✓ The process of establishing specific environmental objectives also requires considerations as different scales, with both bottom-up and top-down approaches being useful.
- ✓ The issue of integration of water policy with other policy areas has proven crucial, and more operational links in the implementation phase to other policy implementation processes are crucial.
- ✓ An important experience is that the stakeholder involvement required by the WFD has proven useful, and in order to be effective, this involvement should start at early stage of the process is important.
- ✓ Trans-national cooperation in the implementation phase in shared river basins is a key component of the WFD. Although PRBs has experienced that this is sometimes very difficult to achieve, it is necessary as well as rewarding, and cooperation at the early stages across national borders will save problems later.
- ✓ In international river basins, it may not necessarily be most useful to achieve complete harmonization, but it is more important to focus on achieving comparable results, despite adopting different strategies.
- ✓ The appropriate scale of Cost-effectiveness analysis (CEA) depends on the problem, river basin or sub-basin. It may not necessarily be best carried out at for whole river basin, instead it is recommend to carry out the CEA on sub-basin level (or smaller segment of the river basin), as part of overall river basin management. This is important in the context of the responsibility of local authorities.
- ✓ As regards resources, it is important to allocate resources early for administration, monitoring and realization of measures /implementation to also find most cost-effective solutions.
- ✓ Legal transposition by the Member State should furthermore be pragmatic to insure real implementation, for instance to make sure it is possible for local authorities to carry out the RBMP in 2009. Adequate tools for local authorities are important.
- ✓ And finally, one question raised by certain PRBs involved in the exercise is if there is currently sufficient knowledge in the river basin management structures to implement the WFD?

I.4. THE WAY FORWARD: TOWARDS IMPLEMENTATION OF THE WATER FRAMEWORK DIRECTIVE

The Pilot River Basins across the European continent have played a vital role in the testing of the implementation guidance documents and other key documents over the past 5 years. The range of areas addressed both in Phases I and II of the exercise is impressive, as it is the diversity of river basins involved. Whilst activities in the first phase focused on testing of guidance documents (see also the report "Pilot River Basin Outcome Report – Testing of the WFD Guidance Documents", 2005, JRC-IES) this second phase has seen an integration of the activities in the different activities under the Water Framework Directive, with a focus on the preparation of the first River Basin Management Plans due in 2009.

For such a complex and integrated piece of legislation as the Water Framework Directive, practical piloting of implementation has been and will continue to be of great importance. However, the nature of this implementation now will by necessity take a somewhat different nature, as the real deadlines approach for the first River Basin Management Plans.

Nevertheless, the need to continue the activities of a network of Pilot River Basins was also agreed in the work program of the Common Implementation Strategy for the period 2007-2009 as agreed at the meeting of the Water Directors in Inari (Finland) on 30/11 – 1/12, 2006 which states:

"In addition to these above mentioned activities, it should be possible and encouraged to organize ad-hoc, one-off workshops on particular subjects in order to promote information exchange. Good examples for such workshops are the Monitoring Programs Workshop in April 2006 in Brussels and the Workshop on River Basin Management Plans in May 2006 in Bonn. Workshop can and should also be organized on an annual basis with the pilot river basins (PRBs) in order to see practical examples of implementation. It is proposed that the pilot river basin network stay together as a network and are continued to be invited to the Working groups to participate. An organization and information exchange between the PRBs and other river basins can take place to the above-mentioned workshops.

The agreement on who should organize such workshops and how the content and the results are shaped, should be discussed on the SCG on a regular basis on proposal on individual countries, organizations or institutions which are interested in organizing such an event." In this context the new organizational structure of the CIS is also presented in figure 2.

In several of the specific working group mandates the role of PRBs are mentioned. The full work program of the CIS 2007-2009 titled "Improving the comparability and quality of the Water Framework Directive implementation - *Progress and work program for 2007-2009"* is available from the Europe website at*:* *http://ec.europa.eu/environment/water/water-framework/implementation.html*.

The future activities of the Pilot River Basins are therefore envisaged as follows:

- ✓ Annual PRB workshops can be organized, which will enable the maintenance of a vital PRB network that can identify new challenges and tackle new areas for pilot activities.
- ✓ Targeted actions linked to working groups will continue, for instance testing of the River Basin Management Plan reporting sheets are currently underway at the time of issuing this report, initiated by Working Group D on Reporting, in view of the upcoming deadlines for reporting. Further work is being carried out by the PRB Group on Agriculture, linked to the "Strategic Steering Group on WFD & Agriculture".
- ✓ Emerging work areas. As the world of water management evolves, there will be a continued need for testing in emerging policy areas. A prominent example is in the area of Flood risk management, where a Directive is expected to be adopted in 2007, which may lead to a need for pilot river basin activities. Other "emerging" work areas are water scarcity and droughts, and issues like climate change adaptation.

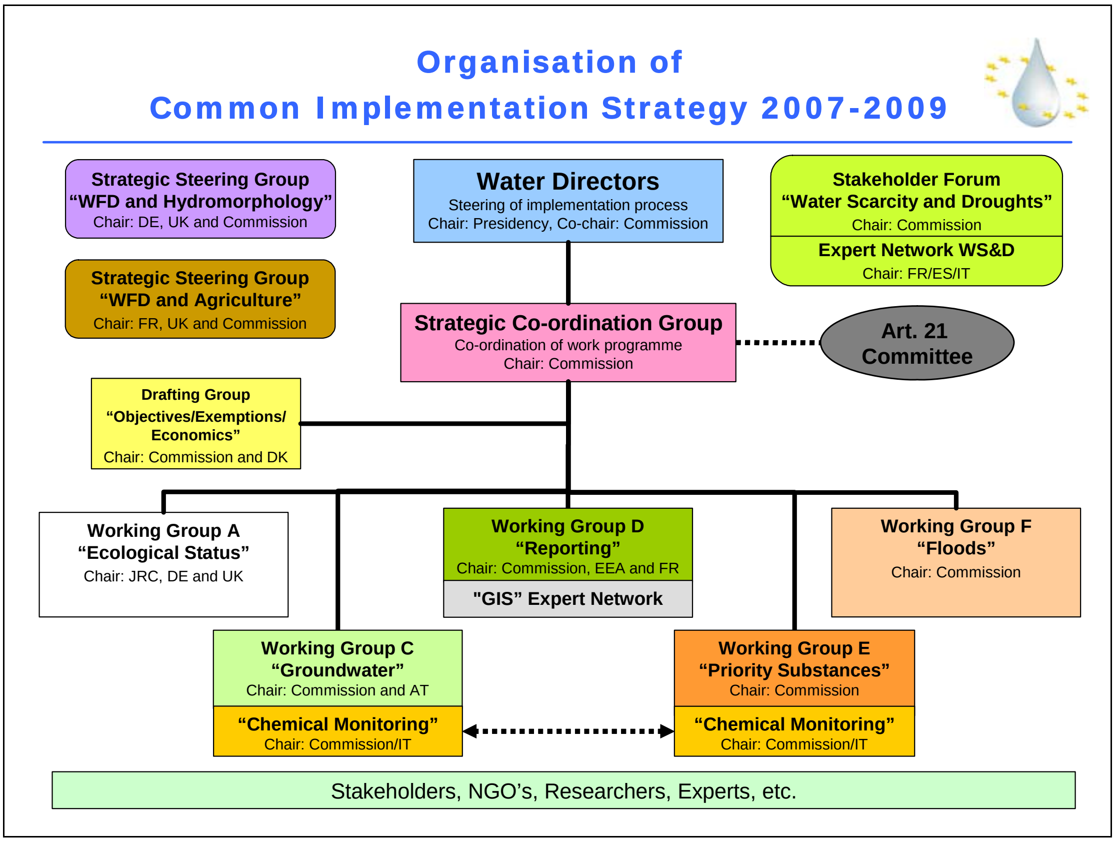

Figure 2. CIS work program 20057-2009

- ✓ Water Information Systems for Europe – RTD. On 22 March 2007, the Commission will launch the new web-portal for all water-based information. This portal will be used for reporting, but also as an interface for the public on water. It is being developed in cooperation with the EEA, JRC, Eurostat and DG Environment. One part of this is dedicated to improving the information flow on research and other projects in the water field – the WISE-RTD. In addition to including information about pilot river basins, it will be an important future interface for translating scientific results with practical implementation. Linked to this is also the important role-played by pilot rivers in the testing of different research projects, such as Floodsite (on flood risk management) and Aquamoney (on economic assessment of benefits and environmental and resource costs).

Finally, this report on activities should also be used as a resource guide on examples of test cases on the implementation of the Water Framework Directive and as a resource guide to the people and administrations who have practical experience from the pilot phase implementation they can share with others across the European continent.

The Commission services wishes to thank all those involved in this Pilot River Basin exercise for contributing to the policy development process by showing examples of practical implementation measures, and as such also proving that the widely debated and analysed Water Framework can contribute positively to integrated water management in European river basins.

PART II

OVERVIEW OF PILOT RIVER BASINS

II.1. WESER – GERMANY (DE)

Where is it

The Weser river basin district extends from central to northern Germany, encompassing parts of the country's central highlands in the south and the central plains in the north; it comprises the Werra, Fulda, Weser and Jade catchment areas. It is situated solely within Germany. On the administrative level, the river basin district is made of seven federal states, with Lower Saxony accounting for the largest share of the district's surface area with almost 29,440 km², Hesse (9,000 km²), North Rhine-Westphalia (4,970 km²), Thuringia (4,440 km²), Saxony-Anhalt (700 km²), Bremen (400 km²) and Bavaria (50 km²). The water management authorities of these federal states have formed the River Basin Commission Weser.

Figure 2. Sub basins and sub units in the Weser River Basin.

Characteristics of the river basin

The Weser River Basin has a catchment size of 49,000 km² and has been divided into the sub basins Werra, Fulda and Weser, the latter being subdivided into the sub units Tideweser, Ober- and Mittelweser, Aller and Leine.

Figure 1. Weser River Basin in Germany showing boundaries of Federal States.

The Werra (298 km) and the Fulda (220 km) originate in the mountainous regions in the south of the river basin and join to become the Weser (427 km) which flows in a northerly direction into the North Sea. Other main tributaries are the Leine (274 km) and the Aller (244 km) coming from the central eastern part of the river basin. The aggregated length of rivers and streams with a catchment size of more than 10 km² amounts to 16,600 km. In addition, approximately 500 km of shipping canals are used as waterways. The Weser basin district also contains 15 large lakes with a total surface area of 53 km², as well as 12 dams that encompass a total area of 26 km².

Figure 3. Upper Weser.

The river basin is situated in the temperate humid climate zone of Central Europe. Whilst the northern part is characterized by the Atlantic climate, the southern part is influenced by continental climate. The average annual rainfall ranges from 600-1,100 mm and the average temperature from 5°C to 9°C depending on the altitude and mesoclimatic conditions.

Figure 4. Stream in central highlands.

Long term average discharges (1941-2002) at the gauging station Intschede (approx. 80% of river basin catchment) are: 327 m³/s (average flow); 118 m³/s (minimum average flow); and 1,230 m³/s (maximum average flow). The Weser is a pluvio-nival type with high water flow in winter and low water flow from June to October.

Figure 5. Stream in central plains.

About 60% of the catchment area is used agriculturally dominated by arable land (48%) especially in the central part of the river basin. Particularly in mountainous areas forest or woodland is prevailing (27%). Urban areas and settlements cover approximately 7% of the river basin. The district is inhabited by 9.3 M people, of whom nearly 75% live in cities with populations exceeding 100,000.

Water quality, particularly organic pollution from point sources, in the Weser river basin district has improved steadily over the past few decades resulting from the technical improvement of sewage treatment. Main pressures in the river basin nowadays are caused by diffuse nutrient pollution and hydromorphological modifications. According to the first assessment (art. 5 of the WFD), 33% of the approximately 1,400 water bodies are possibly at risk to fail the objectives of the WFD and for another 48% further surveys are carried out to collect more data.

Diffuse sources have a strong impact on groundwater bodies; in 62% of the area of the Weser River Basin groundwater bodies are at risk to fail the good status predominantly due to diffuse nutrient inputs. Furthermore, salt waste input from the potash mining industry influences the water quality in Werra, Weser and groundwater bodies in that area.

Key issues addressed in Phase II of the PRB activity

The analysis of pressures and impacts in the Weser River Basin has highlighted the main pressures. There are several issues in the river basin that are being tackled by local or regional authorities. A range of pilot projects are being carried out in the Federal States to find strategies and methodologies to implement the WFD. The River Basin Commission focuses on issues that require a district-wide coordination process:

- ✓ Hydromorphology: River basin wide coordination of identifying objectives and measures to enhance river continuity
- ✓ Nutrient pressures: Analysis of current situation and identification of mitigation measures
- ✓ Integrated River Basin Management: Economic aspects for the selection of cost effective measures
- ✓ Reporting: Harmonisation and visualisation of reporting data

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II.2. ODENSE – DENMARK (DK)

Where is it

The Odense Fjord catchment is situated at the island of Fyn central in Denmark (figure 6). The catchment is draining a land area of some 1060 km^2 and includes 1100 km streams and 2600 lakes and ponds (>100 m^2). Odense Fjord is a shallow estuary of 60 km^2, with a narrow gap to the adjacent inner Danish coastal waters.

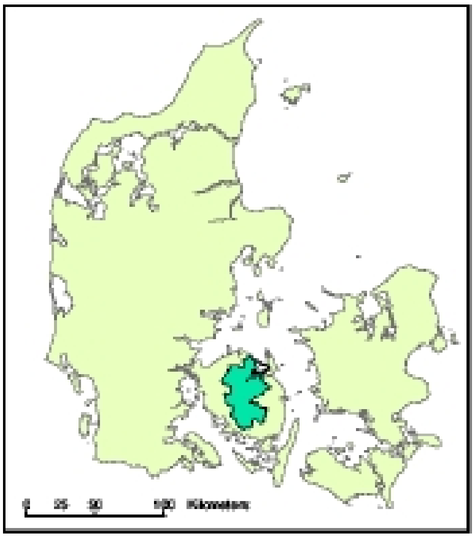

Figure 6. Denmark with the Odense Fjord catchment.

Characteristics of the river basin

Agriculture dominates land use (65%) in the catchment, including approx. 70,000 livestock units. The dominating crops are cereals (2/3 being winter cereals) accounting for 63% of the cultivated land, whereas only 10% of the farmland is grassland. 11% is covered by forest, the dominating species being beech and pine. Other 6% is covered by fens, meadows and salt marshes - a type of land use which in the first half of the 20th century was reduced by more than 50% in order to provide agricultural land. Finally 13% is urban area, including Odense which is the 3rd largest city in Denmark, giving a total population of approx. 240,000 inhabitants in the catchment. Households, industry, motor traffic and agriculture affect the aquatic environment as a result of their release of a range of pollutants.

Environmental state and risk assessment of surface waters

Odense Fjord

Odense Fjord is affected by inputs of nutrients and hazardous substances from the land, atmosphere and adjacent water bodies, and physical disturbances as dredging of shipping routes, building of harbors etc. Land reclamation has reduced the water-covered area by 33% since the 70's. Monitoring carried out by Fyn County Council since 1976 shows that the objectives of the Fyn County Regional Plan are still not met, neither for the open coastal waters, nor the adjacent shallow water areas, fjords and coves, although marked reductions of nutrient input have been obtained since the 80's.

None of the 20 water bodies (figure 7) designated in the Odense Fjord is expected to fulfill the Water Framework Directive criterion of Good Environmental Status (GES) in 2015.

Lakes

The environmental state of 71% of the lakes investigated in the catchment is not satisfactory, and for 15% of the lakes the status is not known. None of these lakes are expected to fulfil GES in 2015 (figure 8). The lakes are affected primarily by nutritional sewage outlets from scattered settlements and diffuse runoff from agriculture. 13 lakes in the catchment have been dried out during the last century, due to land reclamation.

Watercourses

The environmental state of 96% of the 338 water bodies in the 28 water course reaches are not expected to meet the GES objectives in 2015 due to physical conditions and/or wastewater discharges (figure 8). Wastewater from scattered settlements, storm water discharges as well as bad physical conditions caused by among other things heavy-handed maintenance and river regulation are the major causes to this.

Ground water

Drinking water is supplied by ground water of generally good quality. Nitrate in deeper ground water is generally low due to N-reduction in the overlying layers of clay. However, these protective layers are locally thin or absent, resulting in contamination with nitrate as well as pesticides and other hazardous substances.

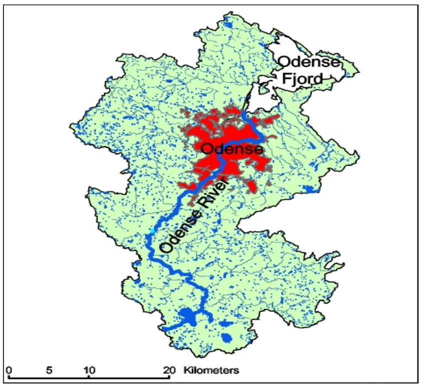

Figure 7. The Odense Fjord catchment with streams and lakes.

Sources of nutrient pollution

Agriculture is the major source of nitrogen pollution accounting for approx. 70% of the waterborne N-sources and approx. 60% of the airborne N-sources.

Total outlets from point sources (municipal waste water, industry and stormwater outlets) in the catchment have since the mid 80's been reduced by about 90% for phosphorus and 60% for nitrogen.

Institutional aspects

Fyn County is the water district authority for the water district of Fyn, until 1st of January 2007, according to the Danish national transposition of the Water Framework Directive,. After 1st of January, the water district authority will be transferred to the national level, due to the ongoing structural reformation in Denmark.

All relevant local, regional and national competent authorities are involved in the Odense Pilot River Basin Project. Fyn County is the lead partner of the project, and thus has the primary role in promoting, establishing and implementing the project.

The project is overseen by three technical advising boards comprising representatives from the national environmental and nature agencies and institutions and the municipalities. NGOs and stakeholders are represented in the committees as well (e.g. the Danish Society for the Conservation of Nature, the national and regional agricultural associations, fishery organizations etc).

Key issues addressed in Phase II of the PRB activity

In the first phase of the Pilot River Basin Project, the focus was on testing the EU Guidance Documents. The main product of this phase was the report "Odense Pilot River Basin, Provisional Article 5 Report pursuant to the Water Framework Directive" (Fyn County, 2003).

In the second phase of the Pilot River Basin exercise, the main focus is on producing a "Pilot River Basin Management Plan", and cooperation between PRBs and the new Working Groups formed under the CIS-strategy. Odense PRB has contributed to:

- ✓ Working Group A "Ecological Status"
- ✓ Working Group B "Integrated River Basin Management"
- ✓ Working Group E "Priority Substances"
- ✓ Strategic Steering Group "WFD and Agriculture".

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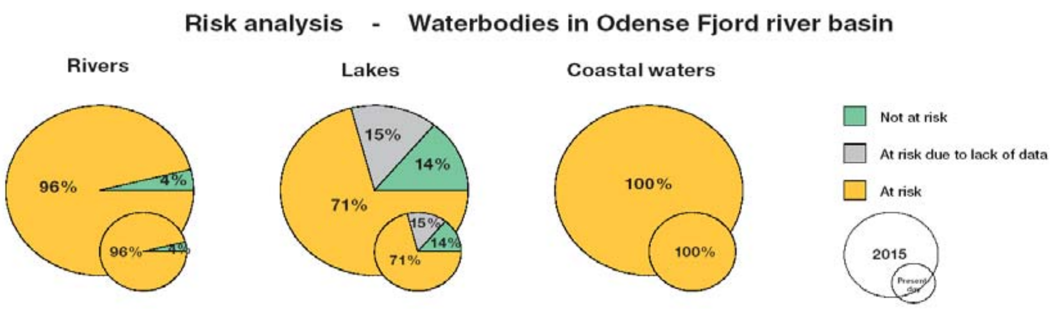

Figure 8. Risk assessment according to the criteria developed in the Odense Pilot River Basin. Present and expected future situation in 2015 for rivers, lakes and coastal waters are shown.

II.3. HARJU – ESTONIA (EE)

Where is it

Harju river-basin sub-district is located in North-Estonia on the territories of 38 Municipalities in 5 - Harjumaa, Järvamaa, Läänemaa, Lääne-Virumaa, and Rapla - counties. The total surface of the municipalities in the Harju sub-district is 8530 km², including both, the costal area and the inland. However, 21 of these municipalities are only inside the sub-district for part of their territory, which means that the sub-district surface as such is 6250 km² making it represent a little under 14% of the corresponding number for Estonia as a whole. Administratively the area counts 7 cities or towns and 39 rural municipalities.

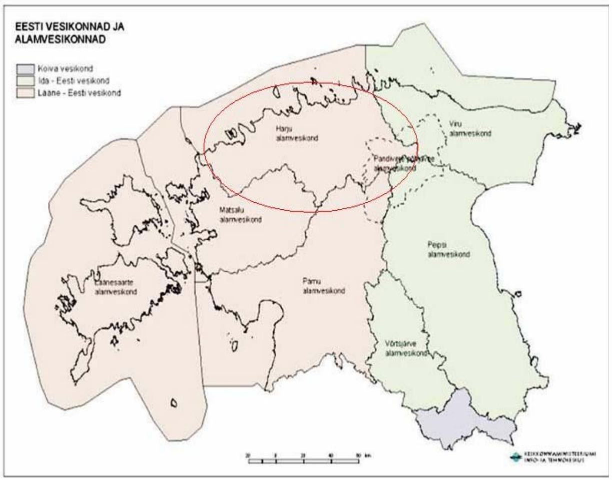

Figure 9.

Characteristics of the river basin

All waters in the sRBD have been divided into water bodies. In total, 150 surface water bodies, 4 coastal water bodies and 6 main groundwater bodies have been identified. There are 13 lake water bodies in Harju sRBD. Forest (58%) and agriculture (31%) are the predominant land uses in Harju sRBD. From the beginning of 2005, 558.000 people live in the HSRB.

Environmental state and risk assessment

The rivers in Harju sRBD are divided into 137 water bodies. On the basis of monitoring data and expert judgment an indication is given of the current physical-chemical and ecological status for rivers. Depending on the classification used (classification systems and environmental objectives are still to be set by MoE), chemical status is below standard for most water bodies, while ecological status varies from moderate to good. Nutrients (Nitrogen and Phosphorus) are the main polluting substances. Further analysis and measures therefore focuses on these substances.

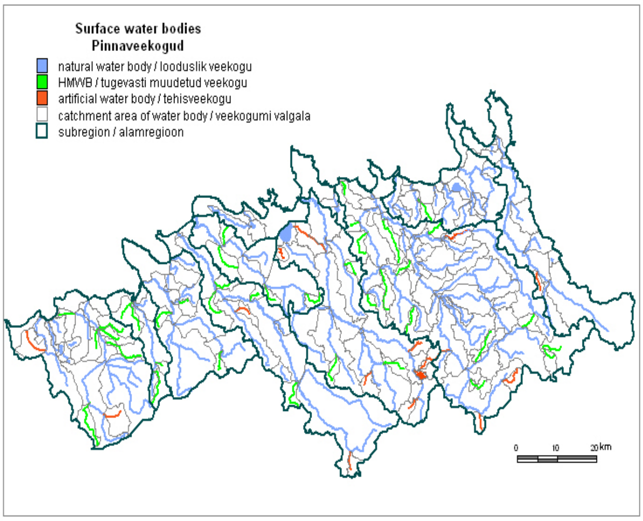

Figure 10.

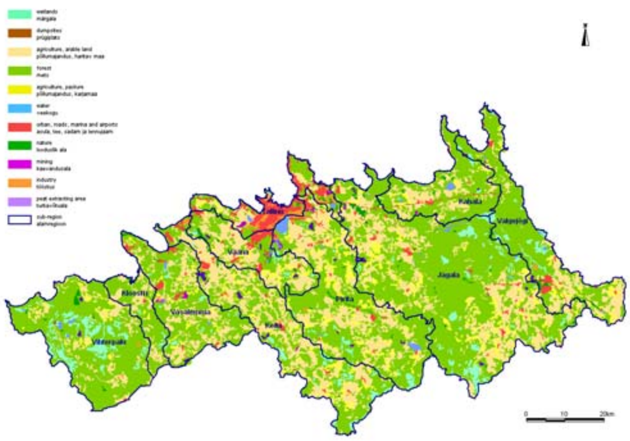

Figure 11.

There are 13 lake water bodies in Harju sRBD. No regular monitoring data is available for lakes in Harju sRBD. The picture appears from expert judgement and available studies that ecological status of lakes is rather variable. Harku lake for instance is in bad condition, while Kahala lake has high status. The figure below shows the water bodies designated in Harju sRBD, which are divided into natural, heavily modified and artificial water bodies.

As the division of the coastal waters into 4 water bodies appears not to be differentiating for the Harju sRBD coastal zone, assessment has been carried out for the whole coastal area at once. Several physico-chemical and ecological parameters are assessed during characterisation. In general, the coastal area is in moderate to good status.

The following types of protected areas are considered and mapped: nitrate sensitive areas, rivers designated for the protection of salmon, bathing waters, Natura 2000 sites, protection zones around groundwater abstraction wells and the surface water catchment protection zone for Lake Ülemiste.

Both quantity and quality issues have been addressed. There are no threats to the groundwater body quality or quantity.

Institutional aspects

Originated from European Union Water Framework Directive, the Government of the Republic validated on the 3rd of April, 2001, with its regulation nr 124 "Appellation of riverbasins and river - basin sub-districts" Harju river-basin sub-district. The water management plan of the river-basin subdistrict is not approved by the Government yet. It will be done by the end of 2007.

Sources of nutrient pollution

It appears that for most water bodies, agriculture is the dominant driver. The second most important driver is emission from animal husbandry. Also forested areas create considerable (but mainly natural) background emission of N and P. Point sources are a major pressure in 8 water bodies. Hydro morphological changes, especially dams, present problems in several water bodies.

In costal waters, nitrogen pollution is caused mainly by inflow from rivers (86%), but also the Tallinn waste water treatment plant is a considerable factor (14%). Phosphorus pollution is mainly caused by internal loading of P from the sediment (95%). Other pressures are of a hydro morphological (dredging) and ecological (introduction of non indigenous species) nature.

Several point sources (boiler houses, waste dumps, military installations etc.) present local pressures to groundwater quality in Harju sRBD. Agriculture is the main diffuse source to (shallow) groundwater. Nutrients (especially N) affect groundwater quality especially in the limestone areas. Pesticides may also present a problem but this remains uncertain.

Impacts from hazardous substances can be severe, but only on local scale. These mainly relate to known point sources (dumpsites, military installations).

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II.4. PANDIVERE – ESTONIA (EE)

Where is it

Pandivere groundwater river-basin sub-district (2382 km^2) is situated in amid of the Pandivere Upland. The Pandivere Upland is gentle, with rotund configuration and higher than surroundings. Its bedrock is made of mid- and upper-ordovician and lower-silurian limestone. A belt of swamps and wellsprings environ the slopes of the Upland.

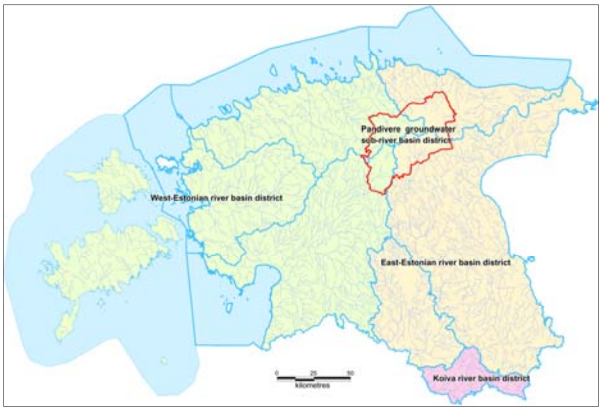

Figure 12.

Characteristics of the river basin

The Pandivere Upland is the largest infiltration area in Estonia – permanent rivers and lakes are missing in the karst area of 1375 km^2 on the central part of the upland.

The snow melt water and rainwater are drained off by sinkholes or seeps through the soil into cracked bedrock, thus replenishing groundwater resources. On the contrary, the bottom of the upland (80…90m) is marked with a tight circle of spring belt, where many rivers and streams emanate.

41% of Pandivere groundwater river-basin sub-district is covered with forest, 37% is arable land, 14% is natural grassland and 3% are swamps and wetlands.

The system of karstwater on the Pandivere arch and on the top of the slopes is constituted before the ice age, but it is actively developing even nowadays. The situation of limestone close to the surface and higher position compared with surroundings causes the draining of surface water and rock karst. Pandivere groundwater river-basin sub-district has over 700 registered karst and over 130 springs.

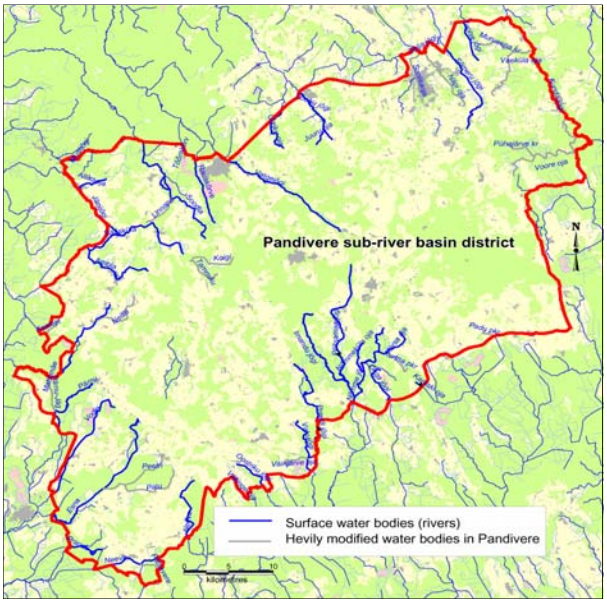

Figure 13.

The bedrock of the Upland is covered with quite thin (thickness some metres) surfacing of quaternary deposites. Calcareous clayey boulder clay, what is surfacing, is good source rock for genesis of high productive soil. It is affirmed by prepotency of the most fruitful cultivation soils in Estonian conditions – brown soils and cambisols in Pandivere. The thickness of the arable land humus layer is 20…30 cm, the topsoil is 40…50 cm. In consequence of long-term agriculture, there are well-cared arable lands, what vary with smaller groves.

Environmental state and risk assessment of groundwaters

In conditions as described before, groundwater is very sensitive in reference to pollution. The pollution in groundwater spreads quickly in karst areas and reaches to springs, at the same time polluting the water of springs and rivers. In that kind of circulating system, the self-purifying capacity of the groundwater is minimal.

Sources of nutrient pollution

There is a clear contradiction between economic interests (specially agricultural production) and long-term water usage and saving valuable water objects. The area is concurrently important as agriculture and water protection area.

The impact of agriculture on water quality has been thoroughly studied in limestone areas such as the Pandivere region. Due to the thin soil cover in limestone areas, fertilizer use correlates very well with groundwater quality. A summary has been made of about 6,000 water samples taken between 1987 and 1993 and a nitrogen balance analysis of different production areas.

When comparing the effectiveness of nitrogen use and the nitrate concentration in individual wells located at the fields, it becomes apparent that an increase in the amount of nitrogen not used by the crops of 10 kg/ha results in an increase in the average groundwater NO_3^- concentration of 3-5 mg/l.

In the 1990's the impact of agricultural activity on the environment has decreased. In 1994, only 53 kg of fertilizers was used per hectare of arable land. Today the number of animals has decreased 60%. At the present time the amount of nitrogen, applied with mineral fertilizers has again increased to 60-100 kg/ha at intensively exploited arable land, whereas the fertilized land area is approximately half of that of the soviet time.

Institutional aspects

Originated from European Union Water Framework Directive, the Government of the Republic validated on the 3rd of April, 2001, with its regulation nr 124 "Appellation of river-basins and river -basin sub-districts" Pandivere river-basin sub-district of groundwater. According to the Nitrate Directive (91/676/EMÜ), the member of the union must determine the areas of polluted groundwater and count them in to nitrate-sensitive areas. The plan of action has to be complied and put into practice to limit the nitrate pollution. Pandivere groundwater's river-basin sub-district is Nitrate Vulnerable Zone as a whole. Estonia has set up the Action Plan for Nitrate Vulnerable Pandivere and Adavere-Põltsamaa Zone for the years 2004 to 2008. The Plan is part of the water management plan of the river-basin sub-district. Plan is approved by the Government on 30.04.2004.

Key issues addressed in Phase II of the PRB activity

The nitrogen pollution is expected to become the main problem in the Pandivere area. An indicator confirming this is the increasing nitrate ion concentration trend in groundwater that is strongly related to the continuously growing concentration of big farms near the settlements.

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II.5. DUERO – SPAIN (ES)

Where is it

The Duero river basin is the largest in the Iberian Peninsula, with a total surface of 97,290 km^2, of which 78,954 km^2 are located within Spanish territory, representing 15.6% of its total surface, and the rest is situated in Portugal.

The main portion of the basin is found within the autonomous region of Castilla y Leon and, to a lesser extent, it also encloses territories belonging to Galicia, Cantabria, La Rioja, Castilla la Mancha, Extremadura y Madrid. The total surface distribution of the basin according to autonomous regions is as follows:

Autonomous Region	Surface in the basin (km^2)	% of the total basin surface
Castilla y León	77,628	98.32
Galicia	1126	1.43
Cantabria	88	0.11
La Rioja	19	0.02
Castilla-La Mancha	45	0.06
Extremadura	35	0.04
Madrid	13	0.02
Total	**78,954**	**100%**

Figure 14. Administrative map of the Duero river basin.

Characteristics of the river basin

From a geological point of view, the hydrographic basin of the Duero River consists of a well-defined geological unit, the Duero depression and its borders. It practically comprises the Northern sub plateau and the limits with its neighboring structural units, i.e. Cordillera Cantábrica, Ibérica, Central and Montes Galaicos-Leoneses.

The climate is Mediterranean, remarkably continental, owing to orographic isolation. It becomes slightly milder towards the border with Portugal, due to the influence of the Atlantic Ocean. The average annual rainfall varies considerably, from values in the range of 400 mm/yr n the central depression to 1800 mm/yr in the surrounding mountain areas and 1000 mm/year in the Cordillera Central and Ibérica. Rainfall is irregular, falling mainly from autumn to spring, but scarcely during the months of July and August.

It has a population of 2.2 M inhabitants, located mainly in the most important cities. There are numerous villages with less than 1000 inhabitants and hardly any town reaches 50,000 inhabitants. 50% of the population is located in the capitals of the provinces.

According to Article 5 of the WFD, a total of 359 surface water bodies and 31 groundwater bodies have been identified in the hydrographic basin of the Duero River.

Regarding surface water bodies, 297 are rivers, 6 are lakes, 6 are artificial water bodies and 50 are highly modified water bodies.12 of the mentioned are at risk of not achieving the environmental goals established by the Directive 2000/60/CE, 292 are awaiting further survey and 49 are not at risk.

Regarding groundwater bodies, 3 of them are at risk of not achieving the environmental objectives established by the WFD. The following table summarizes the conclusions of the survey about human activity impacts on water bodies:

Water resources and uses

The natural average discharge of the Spanish basin is 13,558 hm^3/year, including surface and groundwater resources.

The most important water use is irrigation, with over 3603 hm^3/yr. Irrigated areas take up about 6% of the basin surface, and are responsible for 93% of the total water usage. Urban supply amounts to 214 hm^3/year and industrial uses to 43 hm^3/year. Nearly 10% of those consumptive demands are supplied with groundwater. Furthermore, the Duero Basin Hydrological Plan leaves approximately 745 hm^3/year for environmental purposes, downstream the main reservoirs.

	Certain risk	Risk at survey	No risk	Total
Surface water bodies	3.4% (12)	82.7% (292)	13.8% (49)	(353)
Ground water bodies	9.% (3)	90.% (28)	0% (0)	(31)

Figure 15. Adaja River close to Avila.

Other institutional aspects

Duero River Basin Authority (Confederación Hidrográfica del Duero) was created in 1927 to administrate the use of water in irrigation and hydroelectric power production. Afterwards, this organisation increased its authority with liabilities such as water planning, water quality, flood prevention, environmental issues, issuing of water rights licenses and others. The Authority is directly managed by the Spanish Ministry of Environment.

The river basin Authority competences and its planning are included in the Duero River Basin Management Plans. This document is of a legally binding character and it was approved by Royal Decree no. 1664 of 24 July 1998.

Spain and Portugal have an agreement, (Convenio de Albufeira) that was created to guarantee a harmonised management of all river basins that both countries share .It was approved in 1998, November 30th.

Key PRB activities in Phase II

The Duero River Basin and the Spanish Ministry of Environment are involved in Working Group D on Reporting, within CIS Phase II. The overall objective of this Working Group is to identify information and data to be transmitted and to prepare guidance documents on the transmission and processing of information and data gathered in the frame of the WFD

The Duero River participates to the Pilot river Basin Network in testing the guidance document worked out by Reporting WG.

The key activities to carry out are:

- develop relevant and useful tools to facilitate and improve the electronic reporting of Spanish information to WISE system.

- check GIS and WISE tools made for EC, JRC and others, with the target of helping the reporting process.

Contact and information

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II.6. EBRO – SPAIN (ES)

Where is it

The Ebro river basin is located in the middle of the northeast part of the Iberian Peninsula. The full basin drains a total land area of 86,000 km^2, mainly in Spanish territory, but also including la small portion of France and the small Pyrenean state of Andorra. The watershed area encompasses the territory of 9 autonomous regions (table 1 and figure 1), with very important responsibilities in environmental, territorial and economical issues:

Table 1. Administrative data.

Autonomous regions	Area %	Population %
Aragon	49.2	40.42
Cantabria	0.9	0.66
Castile – La Mancha	1.3	0.07
Castile – Leon	9.5	3.20
Catalonia	18.3	17.81
La Rioja	5.9	9.85
Navarre	10.8	18.87
Vasque Country	3.1	8.95
Valencia	1.0	0.17

Figure 16. Spanish autonomous regions of the Ebro river basin.

Characteristics of the river basin

The Ebro river catchment area has a population of 3 M inhabitants, not evenly distributed. The overall population density is approximately 34 inh./km^2. However, the population of the nine mayor cities amount to 50% of the total, while 40% of the basin surface has less than 5 inhabitants/km^2.

The climate is Mediterranean, with a wide range of variation in the annual precipitation, from less than 200 mm in the central part of the basin and nearly 2000 mm in the mountain region of the high Pyrenees. Besides, in the central region, there are very warm summers which determine a great necessity of water for irrigation. The average water requirement for irrigated crops has been calculate in 8000 m^3/ha.

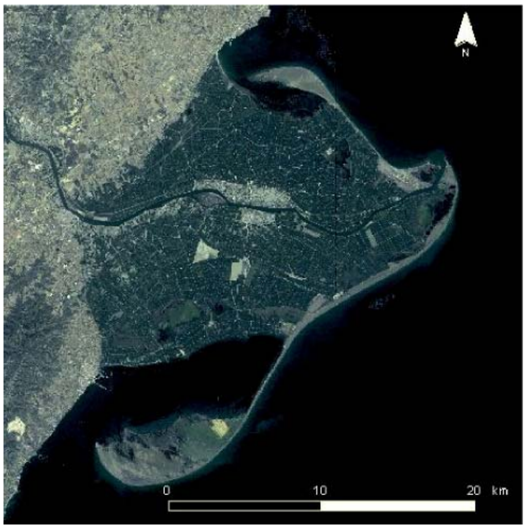

Figure 17. False colour Spot and Landsat TM images combined, showing the Ebro delta into the Mediterranean sea.

The fluvial network of the Ebro river basin amounts to 13,000 km length. It has been divided in 1446 fluvial segments, grouped in 697 river water bodies; 92 surface water bodies have been identified as lakes and 105 as groundwater bodies. In addition, there have been established 8 types for rivers, 10 for lakes, 2 for transitional water bodies and 1 for coastal waters.

The results of the assessment of the impact of human activity on the status of surface water and groundwater reveal that the 60% of the fluvial network is at risk of failing to meet the environmental quality objectives; moreover, there are 46 groundwater bodies needing further characterization in order to establish a more precise assessment of the significance of the risk.

Water resources and uses

The discharge of the Ebro river basin to the Mediterranean Sea is very irregular. The natural average amounts to 18,000 hm^3/yr. However, in the last decade the flow has been less than 9000 hm^3/yr, including years as 1989/90 with a total annual flow of 4300 hm^3. Irregularity, as in other Mediterranean basins, is one of the main characteristics of Ebro River.

The main water uses in the Ebro district are: 1) irrigation, with 800,000 hectares requiring a supply of over 6310 hm^3/yr; 2) urban, with 506 hm^3/yr; and 3) industrial, with 250 hm^3/yr. Moreover, there are other demands without consumption as hydroelectrical power (41,100 hm^3/yr) and continental fisheries (1000 hm^3/yr). In addition, maintaining the ecological status of the Ebro estuary requires 3100 hm^3/yr as environmental discharge.

Figure 18. Literola lake in the central Pyrenean mountains.

Other institutional aspects

The Ebro River Basin Organization *(Confederacion Hidrografica del Ebro)* was created in 1926 to manage water resources mainly in irrigation and hydroelectricity power plants. Since then, other tasks have been added, such as water planning, water quality, flood prevention and environment issues, issuance of water use licenses and others. The authority acts now under the Spanish Environment Ministry.

On 15th February 1996 the Water Council of Ebro River Basin gave their approval to the Ebro Basin Hydrological Plan proposal, and finally the Plan was approved by Royal Decree no. 1664 of 24 July 1998.

Key issues addressed in Phase II of the PRB activity

The Ebro River Basin is involved, together with the Spanish Ministry of Environment, in Working Group D on Reporting, GIS and WISE within CIS Phase II

The key activities to carry out are:

- ✓ Contribute to develop and to draft guidance documents for the transmission and processing of information and data gathered under the WFD.
- ✓ To develop relevant and useful tools to facilitate and improve the electronic reporting of Spanish information to the WISE system.
- ✓ To check GIS and WISE tools made for EC, JRC and others, with the target of helping the reporting process.

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- ✓ www.chebro.es
- ✓ oph.chebro.es
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II.7. GUADALQUIVIR – SPAIN (ES)

Where is it

The Guadalquivir river basin is located in the Southern part of the Iberian peninsula, covering an extension of 57,527 Km^2.

It is framed by specific geographical elements such as the sharp borders of Sierra Morena in the North, the mountainous Cordilleras Béticas in the South, developing along the SW – NE axis, and the Atlantic ocean in the West.

The basin comprises 12 Spanish Provinces grouped in 4 Autonomous Regions: Andalucía, Castilla-La Mancha, Extremadura and Región de Murcia; over 90% of its area belongs to Andalucía as the next table and figure show:

Autonomus Region	Province	(km^2)	(%)
Andalucía	Sevilla	14,001	24.34
	Jaén	13,002	22.60
	Córdoba	11,135	19.36
	Granada	9,960	17.31
	Huelva	2,552	4.44
	Cádiz	532	0.92
	Málaga	489	0.85
	Almería	229	0.40
Castilla-La Mancha	Ciudad Real	3,300	5.74
	Albacete	800	1.39
Extremadura	Badajoz	1,411	2.45
Región de Murcia	Murcia	116	0.20

Figure 19. Administrative distribution in Guadalquivir river basin.

Characteristics of the river basin

The whole Guadalquivir river basin can be split in three structural units: the Sierra Morena plateau, the Cordilleras Béticas mountain range and the Guadalquivir valley, open to the Atlantic influence. These units have a strong influence on the inner characteristics of the basin and determine the fluvial network, the hydrological regime, the water quality and the erosion susceptibility.

Figure 20. Typical landscape of most of the Guadalquivir river basin.

The basin has a population of approximately 4.3 M inhabitants, 56% of them in urban areas bigger than 20.000 inhabitants and 31% in the four capitals bigger than 100.000: Sevilla, Cordoba, Granada and Jaen.

The climate is Mediterranean with remarkable special areas spread across its spatial domain. One of the most important factors is the precipitation, with high interannual variability (very wet versus very dry years). The average annual rainfall is 570 mm, ranging between 500 mm and 700 mm in most of the territory. This figure is exceeded in certain mountainous areas as Sierra de Cazorla, Sierra de Aracena, Sierra Nevada, receiving over 1000 mm of precipitation annually. There are also areas, mostly in the eastern sector, with less than 300-400 mm/yr.

According to the report of Article 5, there are a total of 325 surface water bodies and 58 groundwater bodies in the Guadalquivir river basin. The assessment of the impact of human activities on the status of surface waters and groundwater results in 12.6% of the surface water bodies and 53.44% of the groundwater bodies at risk of failing to meet the Good Ecological Status defined by the WFD, while 24.9% of surface and 10.34% of groundwater bodies are not at risk. The rest of water bodies are under evaluation, mainly due to the lack of data.

Water resources and uses

The Guadalquivir Hydrological Plan establishes that the natural water resources are 6700 hm^3/yr, although these resources are highly regulated all over the basin to cope with interannual variability.

Agriculture represents the most important water consumer: there are 7140 Km^2 of irrigated land, using 78% of the total available water resources. The domestic, urban and industrial sectors use 16% of the resources; the remainder is dedicated to maintaining environmental minima and keeping security margins in reservoirs. It's also important to mention the effort done by farmers in order to modernise the irrigation systems. Currently the surface with located irrigation attains the remarkable figure of 3330 Km^2 (47% of total).

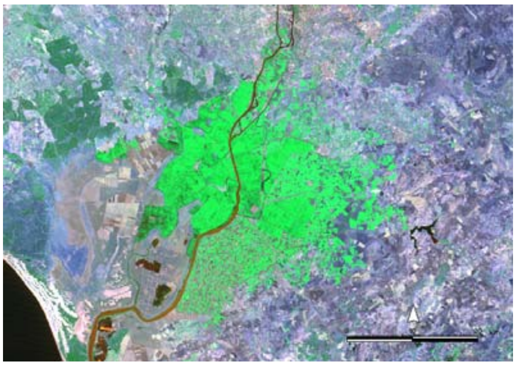

Figure 21. Irrigated agricultural area in the lower part of the Guadalquivir.

Other institutional aspects

The Guadalquivir River Basin Authority (Confederación Hidrográfica del Guadalquivir), directly managed by the Spanish Ministry of Environment, was created in 1927 to administrate the use of the water in irrigation, urban water supply and urban sanitation. After this, the organization increased its authority with water planning, water quality, flood prevention, environmental issues, issuing of water rights licenses and others.

In the 70's the Guadalquivir River Basin Authority needed an instrument to organize the future actions in a rational way and created a pioneer Hydrological General Plan. This plan was organized in two phases. The first phase made an in deep analysis of the actual state and the second and posterior phase established the exploitation possibilities of the hydrological resources.

Nowadays, the river basin competences and its planning are included in the Guadalquivir River Basin Management Plans. This document is legally binding, and was approved by Royal Decree 1664, 24 July 1998.

Key issues addressed in Phase II of the PRB activity

The Guadalquivir River Basin and the Spanish Ministry of Environment are included in the Phase II of the WFD for the period 2004-2006, participating on the *Strategic Steering Group WFD and Agriculture*.

The main goal of this SSG is to identify the agricultural related problems, i.e. main bottlenecks for the achievement of the WFD objectives in most of the SM. Moreover, this SSG should propose action lines that make use of the WFD and the CAP instruments in order to fulfil these objectives.

The Guadalquivir River Basin is involved in a Pilot River Basin Network whose key activities are:

To develop a number of Pressure and Impact Indicators related to the agriculture using spatial analysis.

To study the existing measures related to the WFD and CAP policies and analyse their potential use in order to help achieving the WFD objectives by means of proposing an initial Program of Measures for the basin.

Contact and information

More information about the Guadalquivir River Basin can be found at:

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II.8. NEISSE – GERMANY (DE)

A description for the Neisse PRB was not provided.

II.9. JÚCAR – SPAIN (ES)

Where is it

The Júcar River Basin is located in the East of Spain.

Characteristics of the river basin

It covers an area of 42,989 km^2, with land of 4 different Spanish Autonomous Communities. The population is about 4,360,000 inhabitants, but about 1,400,000 equivalent inhabitants need to be added due to the tourism occurring primarily in the coastal areas.

Figure 22. Territorial area of Júcar RBD.

The area presents a Mediterranean climate, with an average annual precipitation of 500 mm, varying from 250 mm in the South to about 900 mm in the North.

The most important rivers in the basin are the Júcar (509 km of length), the Turia and the Mijares. There are 52 hydrogeological units, from which 6 are shared with other territorial areas. There are numerous valuable wetlands, 4 of which are RAMSAR areas of international importance. Among these, the lake of the Albufera, receiving surface water and groundwater, stands out for its rich ecosystem and covers an area of 21,120 ha.

The total water demand is 3650 hm^3/yr, being distributed into sectors in 720 hm^3/yr for urban use, 2785 hm^3/yr for agricultural use, 110 hm^3/yr for industrial use, and 35 hm^3/yr for refrigerating energy plants. Thus, the agricultural demand represents 76% of the total.

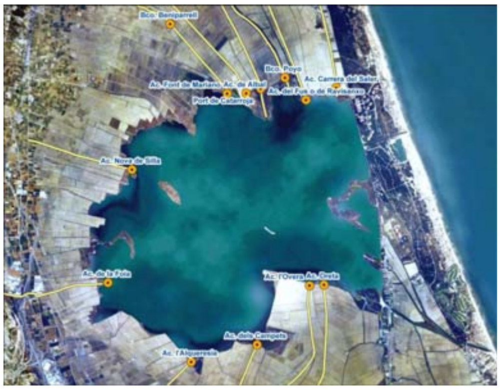

Figure 23. The Albufera Lake.

Groundwater resources are about 70% of Júcar basin's global resources. At present, the use of groundwater is highly important in the basin, with 1700 hm^3/yr dedicated to agricultural and urban water demands.

The overexploitation of groundwater has produced hydrogeological problems, saline water intrusion in some coastal areas, and diffuse pollution from agricultural practices.

Important and recent efforts have focused of the use of non-conventional resources by increasing the reuse of treated wastewater and desalination plants. About 26% if the total water discharged is being reused

Key issues addressed in Phase II of the PRB activity

The Júcar PRB is collaborating with the Working Group B. Activities planned for 2006 were:

- Estimation of pressures and gaps for the baseline scenario in 2015

- Development of a catalogue of local measures, determining their costs and effectiveness

- Development of a methodology to integrate the water quantity, water quality and economic models for the CEA

- Pilot study to test the methodology for selection of the program of measures

- For the pilot study, simulation of different combination of measures to assess effectiveness in reducing the gaps, and selection of the least-cost combination of measures that achieve the objectives

- Generalization of the approach to the Júcar PRB

Contact and information

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II.10. Gascogne – France (FR)

Where is it

In the Adour - Garonne District (in the South-West of France), the Gascogne Rivers (*Baïse, Gers, Gimone and Save rivers*) are a hydrographic unit of reference (fig.1), with several water bodies (37 rivers sections).

Characteristics of the river basin

This PRB has a size of 6800 km² (6% of the District), with a population of 263,000 inhabitants (4% of the permanent population, INSEE 1999). According to the local basins, 60 to 80% of the total acreage is used for agriculture (figures 2 and 3) with crops such as maize, wheat, sunflower, soy bean, and breeding (ducks, cattle).

Figure 24. The Gascogne Rivers in the District (source: AEAG, IGN BD Carthage)

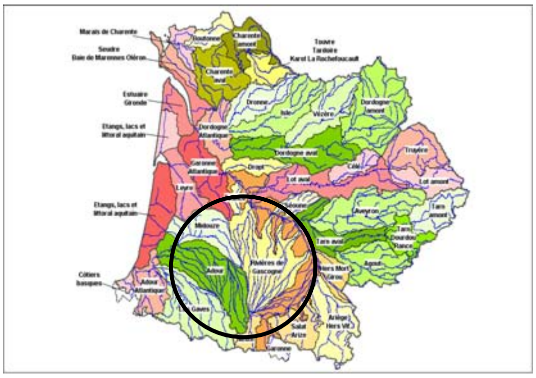

Figure 25. Land use (source: AEAG, IGN BD Carthage, IFEN, 2003/Corinne Land Cover).
Legend: yellow: arable land; brown: vineyards, light green: grassland, green: forest.

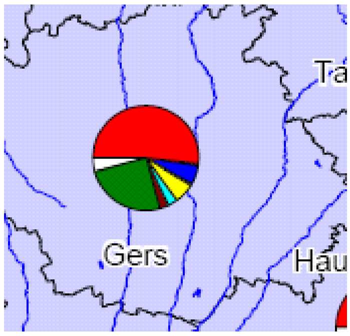

Figure 26. Main farming systems in this area (Gers department) (source: AEAG, IGN BD Carthage 2003/Agreste 2000).
Legend:
red: crops; green: crops and breeding; blue: vineyards; yellow: cattle; blue: ovine or caprine races.

Objectives and institutional aspects

This PRB is focused on the agricultural diffuse pollutions (nitrogen and pesticides). According to the article 5 analysis, they are a very important stake for the District, especially for certain areas like Gascogne Rivers.

Its main objective is to support the identification and the implementation of adapted measures in order to reduce the impact of agriculture on water pollution.

It's co-led by three organizations:

- ✓ the Adour-Garonne water agency (AEAG),
- ✓ Ecobag which gathers several research organizations from the Adour-Garonne basin,
- ✓ the regional and basin representation of the ministry of ecology (DIREN de bassin).

Its actions have been supported by:

- ✓ the involvement of stakeholders, decision makers, associations and scientists,
- ✓ the transfer of research results, knowledge and tools.

Key issues addressed in Phase II of the PRB

In 2005 and 2006, the Gascogne PRB has contributed to 2 working groups:

The PRBs agriculture group (led by the Joint Research Center) depending on the Steering Strategic group "WFD and agriculture": the PRBs have been a "pilot window" on the following areas of work :

- ✓ assessment of the importance of pressures and impacts from agricultural activities;
- ✓ report on planned programmes of measures.
- ✓ Working Group B (Integrated River Basin Management), on:
- ✓ cost-effectiveness analysis,
- ✓ link to research.

Contacts and information

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II.11. SCALDIT / SCHELDT PRB (FR / BE / NL)

Where is it

The river Scheldt rises in northern France, and flows then through the Walloon Region, the Flemish Region and the Netherlands before running into the North Sea. The length of the river is 350 km. The entire Scheldt river basin district has a surface of 36,416 km² and a population of 12.8 M inhabitants. The ecoregion for the rivers and the lakes is the western plains. For the transitional and coastal waters, the ecoregion is the North Sea.

Characteristics of the river basin

An important part of the river Scheldt is canalized. More than 250 weirs and sluices constitute the artificial connections between parts of the river and between the river and its tributaries and canals. The population density varies strongly in the different sub-basins (between 100 and 1200 inh/km²). The river basin district of the Scheldt has a very dense network of waterways, railways and motorways. The inland navigation network is strongly developed and is for the most part adapted to the European dimension of 1300 tons. The land use of the Scheldt river basin district is varied. The river basin district is highly urbanized. It contains several industrial areas. The areas reserved for agricultural purposes, are quite consistently spread over the whole territory. Woodlands take up only a restricted part of the total surface. Important wetland areas are situated along the Scheldt between Ghent and Vlissingen.

The transnational characterization of the Scheldt IRBD revealed that this district is heavily pressurized. Most watercourses in the district are subject to domestic, industrial and agricultural pressures from their source to their mouth, pressures which have a significant impact on the aquatic system.

Indeed, all (investigated) transboundary watercourses and more than 80% of groundwater bodies are at risk of not achieving the objectives or there are at least serious doubts of their achievement of the objectives. Therefore, it is clear that specific measures will be required at district level to achieve the WFD objectives.

Key issues addressed in Phase II of the PRB activity

River basin management planning in an international river basin district: definition of significant water management issues, work programme and table of contents for the international river basin management plan for the Scheldt.

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II.12. TEVERE – ITALY (IT)

Where is it

The Tevere is the largest river basin in central Italy draining a land area of some 17,500 km^2. It includes parts of the following administrative Regions: Umbria, Lazio, Toscana, Abruzzo, Marche, Emilia-Romagna.

The city of Rome is located in the lower course of the Tevere River, near the mouth. The Tevere river basin's population accounts for 4.344.000 inhabitants (population census from 2001), of which 70% lives in the urban area of Rome, about 10% in five of the main cities (Rieti, Perugia, Terni, Tivoli, Spoleto), and the rest in the other small municipalities

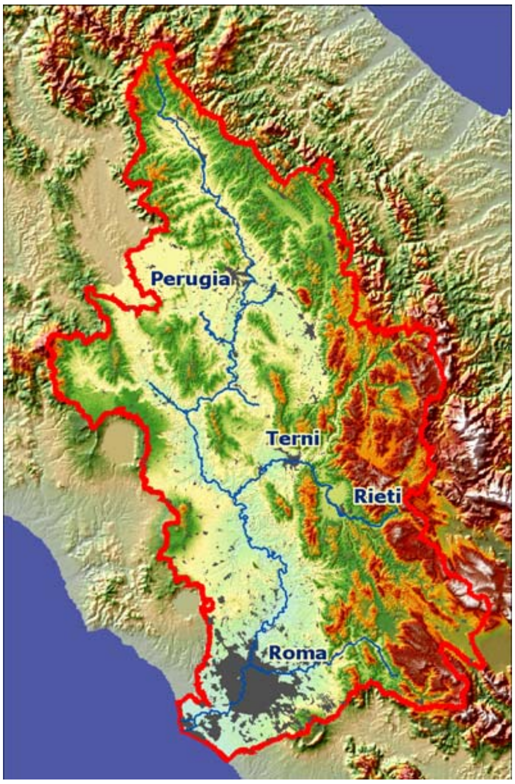

Figure 27. The Tevere catchment (courtesy of Tevere River Basin Authority).

Characteristics of the river basin

Water circulation in the Tevere river basin is influenced by different hydrogeological environments, which determine different ways of interaction between surface water and groundwater (see par III.8.2).The Tevere River basin is located in central Italy and belongs to Ecoregion 3 for rivers and lakes and Ecoregion 6 for transitional and coastal waters (Annex XI Directive 2000/60/CE).

Mean annual precipitation is about 1200 mm; it ranges from 700 mm at sea level to 2000 mm along the central ridge.

The average precipitation regime is: Autumn 35% in 25 raining days, Winter 25% in 30 raining days, Spring 30% in 30 raining days, Summer 10% in 10 raining days. Mean annual temperature varies between 16°C at sea level and 5.5°C at 1800 m asl.

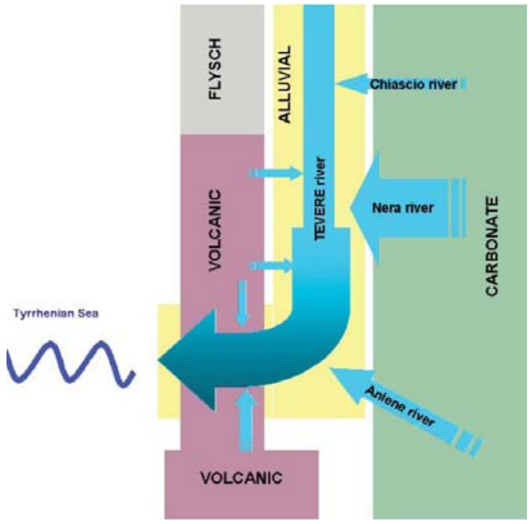

Figure 28. Water circulation scheme of the Tevere river basin.

During the summer months water circulation is mainly fed by groundwater or water resources stored in artificial reservoirs. On this basis, the perennial surface water network was identified and river water bodies were defined. A total of about 200 rivers, 22 lakes, 1 transitional and 3 coastal water bodies were classified. Regarding groundwater, 62 main water bodies located in 27 hydrogeological structures were identified. 14 carbonatic structures, with about 90 main springs, localized and linear springs, supplying an average discharge of about 100 m^3/s; 3 volcanic structures, with springs supplying a mean discharge of about 12 m^3/s; 9 alluvial structures, supplying a mean discharge of about 9 m^3/s; 1 coastal structure.

The river discharges an average 80 m^3/s during the summer, and 3500 m^3/s during extra-floodings.

The Tevere River flow is controlled by several hydroelectric power stations, the main one of which is Corbara (near the town of Terni); other hydroelectric plants are in the main tributary (Nera river).

The Tevere river basin's landscape is very diverse and varied depending on the different morphological and structural environments, which influence distribution of anthropogenic activities.

The dominant land use is agriculture which accounts for some 53%, approximately 39% is forested and approximately 5% is urbanized.

Figure 29. Peschiera Spring (courtesy of ACEA-ATO2).

Key issues addressed in Phase II of the PRB activity

Phase II of the Tevere PRB's activities within the CIS WGs was coordinated on a national level by the Italian Ministry of the Environment (Ministero per l'Ambiente e la Tutela del Territorio – MATT), which identified and coordinated the activity of all the Italian experts in the WGs.

The Tevere PRB's experts participated to WG-C on Groundwater and were also involved in the Bridge project – (Background cRiteria for the IDentification of Groundwater thrEsholds). This project is linked to the WG-C activities. In those activities they developed some case studies.

The experts participated in WG-B Integrated River Basin Management in the Water Scarcity activity.

The Tevere River Basin Authority supported the activities within the Expert Advisory Forum "Flood Protection" set up by the EC to follow the development of the Flood Directive Proposal, EXCIMAP - European exchange circle on flood mapping and EXILUP - European exchange circle on land use management.

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II.13. SULDAL – NORWAY (NO)

Where is it

The Suldal River Basin is small to medium sized at 1460 km^2. The basin has large areas of pristine nature as well as heavy modifications due to hydropower production. It is representative for the topography, hydrology, settlement pattern and human influences prevailing in the north Atlantic coastal region of Norway.

Figure 30. Location of the Suldal River Basin.

Acidification and liming

Acidification due to long range transported pollutants has been a serious problem due to heavy loads, acidic bedrock, thin soils and low neutralizing capacity. Several tributaries to the river have been limed, as well as the outlet from the lake Suldalsvatnet. Due to reduction of emissions, acidification is not considered to be a major cause of significant risk in 2015.

Ecological status

The ecological status in the majority of the water bodies is high, or not influenced by human activity, except for acidification. About half of the identified water bodies have been preliminary defined as heavily modified water bodies.

The annual precipitation is high, and annual mean flow amounts to 105 m^3/s. The population density is about 1.7 inh./km^2. The catchment is characterized by a deep, narrow glacial valley, including the deep lake Suldalsvatnet (376 m deep, 28 km^2). Large areas of the catchment are mountainous plateaus, mainly on poor, granitic bedrock. Local pollution is of low significance in the water bodies of this river basin.

Hydropower production - salmon river

The river basin is heavily impacted by hydropower regulation. The river basin accounts for approx. 5 % of the total Norwegian production of electricity. Large research and management projects have been carried out in the river basin, mostly connected with the impacts of hydropower on aquatic ecology, focusing on wild salmon in particular. The River Suldal (called Suldalslagen, the lowest part of the basin) is one of Norway's most famous Atlantic salmon rivers, known for especially large fish.

Figure 31. Lake Bldsje – the largest reservoir in Norway.

Marine impacts

There is quite extensive fish farming, mainly salmon and trout, in the fjords outside the Suldal River Basin. This inflicts the watershed by introducing alien genetic material to the natural salmon stock, as well as parasites. The fish farming may cause local pollution problems in the marine environment. The PRB study has so far mainly focused on freshwater bodies.

Key issues addressed in Phase II of the PRB activity

Two counties and three municipalities have been engaged in the PRB as well as various stakeholders like a hydropower company and some NGOs. A delay in the official adoption of the Water Framework Directive has delayed the completion of the legal framework in Norway. This has so far led to less local and regional involvement than originally planned for.

Figure 32. The municipality centre at Sand at the outlet of the river.

The topics that are focused in the second phase (2005-2006) of the PRB study are as follows;

- ✓ Environmental objectives for heavily modified water bodies.
- ✓ Streamlining WFD planning processes with upcoming revisions of licensing conditions.
- ✓ Cost effectiveness analyses (CEA) with special emphasis on effects of measures implemented in regulated rivers and lakes.
- ✓ Monitoring heavily modified water bodies.
- ✓ Proposal for important elements in a management plan for the Suldal River Basin.

Organisation of the PRB study

A national steering committee is appointed for the PRB study, with representatives from five governmental departments with national responsibility for various aspects of environmental and resource management, including legislation, control and licensing for various activities. The field work in the PRB study will be performed by contracted consultants. The Norwegian Water Resources and Energy Directorate (NVE) is the main responsible institution for the PRB, warranting the availability of the necessary resources. The PRB study will to a large extent make use of national projects where relevant results can be discussed and fed into the various European working groups.

Contact and information

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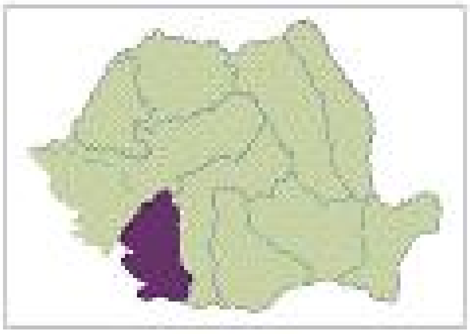
II.14. JIU – ROMANIA (RO)

Where is it

The Jiu river basin is located in the South -West part of Romania.



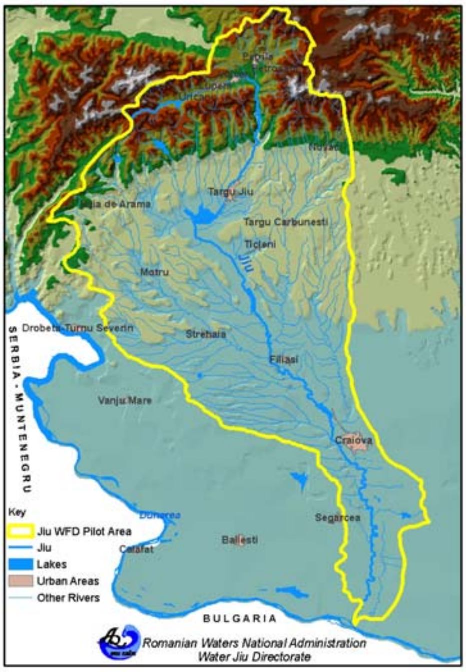


Figure B: Jiu River Basin

Figure 33. Romania with the Jiu Water Directorate.

Characteristics of the river basin

The Jiu river basin covers a surface of 10,080 km^2, with a length of river network of 3876 km and an average density of 0.34 km/km^2. 21% of the river network length suffers from drought conditions. The Jiu river length is 339 km. Also, the Jiu river has 32 tributaries, and the most important are: Jiul de Est, Sadu, Gilort, Amaradia, Tismana, Jilt and Motru. The other tributaries are small, but with significant flow, because of the abundant precipitations (900-1000 mm) from their origin area.

Natural lakes (>0.5 km^2) are not typical for this river basin, but there are 12 reservoirs located on the Jiu river and its tributaries.

In the Jiu river basin the arable land covers 50.5% and the forests means 40% from the total area. Urban and industrial areas represent 5.1% from the total surface.

The relief is mainly of hills (47%) and planes (32%) with a small area of mountains (21%). The climate is temperate continental (the mean annual temperature is 10.5^0C), and the mean annual precipitation between 400 and 1200 mm per year.

In this area the population is about 1.064 M inhabitants, out of which 63.5% live in urban area (14 towns). All the towns from the basin are located near the streams; some of them are traversed by these.

Figure 34. Jiu River - upstream Danube confluence.

12 important reservoirs with a total volume of 72.5 Mm^3 were built to provide the water supply for different users. The total resource of surface water is about 2672 Mm^3/yr, out of which about 2109 Mm^3/yr could be used. The ground water resource is 563 Mm^3.

Environmental state of surface waters

Due to the economical development between 1960 and 1989, the water quality has worsened from the reference state of the 50's. After 1989, the state of water quality has improved due to the decline of socio-economic activities and the application of economical mechanism in the water field, including the "polluter-pays" principle. Significant pollution point-sources are the urban settlements, discharging untreated or only mechanically treated wastewater, and the industrial companies (chemical, mining, oil-chemical, machine construction, material construction, food). All users draft water from the main streams and due to this aspect the water quality is influenced by the discharged wastewater, in general, insufficiently treated. Diffuse pollution sources are represented by the agricultural activities (application of fertilizers and pesticides and animal breeding) and the urban and rural areas taking into account the small percent of the population connected to the sewerage system, as well as the improper waste storage. In the pressures and impact analyses process the main problem encountered was the lack of monitoring data on priority substances/priority hazardous substances concentrations both discharged by the pollution sources and existing in the aquatic environment.

According to the Article 5 of the WFD, a total of 241 surface water bodies have been delineated. The average length of stream water bodies is 21,9 km.

In present, all water categories from the river basin (rivers, natural lakes and reservoirs and ground waters) are monitored, from physico - chemical and biological point of view. So far, the quality of 1214 km streams is controlled with 42 monitoring sections which are, generally, placed in areas where the quality is susceptible to be modified because of the pressures. Presently, there are on going activities for developing the monitoring system in line with the WFD and the other EU directives requirements.

Key issues addressed in Phase II of the PRB activity

Commitment and resources

In this project, 10 persons are involved, 3 from the National Administration "Apele Romane" and 7 from the Jiu River Basin Directorate - Management Plan Office and Monitoring and Water Quality Protection Office. 40,000 Euro have been allocated for the project.

Institutional aspects

National Administration "*Apele Romane*" is the competent authority in charge of the implementation of the WFD through the River Basin Directorates, which are organized at river basin level. The administration of the Jiu River Basin is carried out by the Jiu River Basin Directorate, as well as by the Water Management Systems Dolj, Gorj and Mehedinti at the county level.

Figure 35. Jiu River - Rovinari Industrial Area.

All national, regional and local relevant authorities have been involved in the Jiu Pilot River Basin project. The Jiu River Basin Directorate has the most important part in achieving the project objectives at basin level, as well as the National Administration „Apele Romane" at the national level. The Jiu Basin Committee ensures the public information, consultation and participation in the water field decision making for the Jiu catchment area.

Figure 36. Stream segment from the Jiu Catchment.

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II.15. RIBBLE – UNITED KINGDOM (UK)

Where is it

The Ribble River Basin is located in the North West River Basin District. The River Ribble rises in Pennines to the west of the basin and flows 110 km before running into the Irish Sea, near Preston. The rivers Calder, Darwen, Hodder and Douglas join the Ribble draining a total land area of 2568 km^2.

The area has a population of 1.25 M and has diverse land uses. Although the basin is predominantly rural (90%), there are a number of urban areas, including Preston, Blackburn, Wigan and Blackpool. There are numerous areas protected for their conservation value and many of the rivers provide good habitat for salmon and otters, whose numbers have increased over recent years.

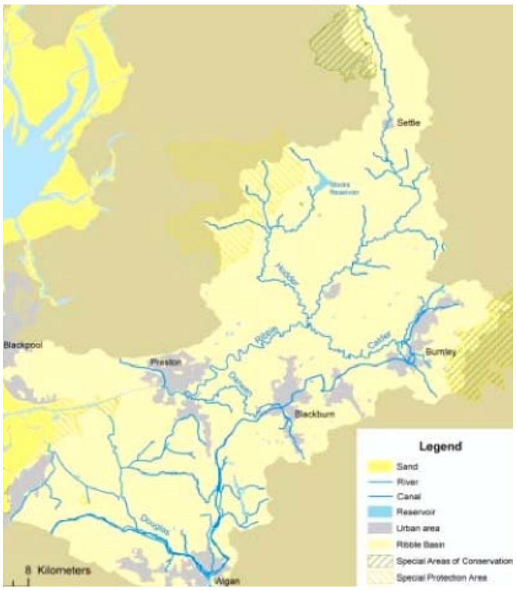

Figure 37. Ribble River Basin.

Characteristics of the river basin

The upper basin is dominated by agriculture. Here diffuse pollution is regarded as one of the main environmental issues. Elsewhere industrial areas centred on east Lancashire reflect altogether different pressures on the water environment.

Flows in the rivers are largely natural, although a number of reservoirs, used for public water supply regulate the flow on several rivers, the largest being Stocks Reservoir on the River Hodder, and the Rivington Complex, in the upper reaches of the Douglas catchment. Annual precipitation ranges from 850 to 1700 mm/yr.

There is a large coastal area, with nine bathing beaches and the largest tourist destination in Northwest England, Blackpool.

Figure 38. Ribble River.

Key issues addressed in Phase II of the PRB activity

The Pilot was launched in June 2003 and comprises two key phases of work:

Phase 1: Testing of European guidance on planning process and public participation (completed in May 2004); and

Phase 2: Preparation of a prototype river basin management plan and programme of measures for the Ribble Basin, involving all stakeholders by July 2007. This will contribute to the Water Framework Directive implementation as part of the Northwest River Basin District Plan.

In addition, during Phase 2 of the PRB exercise, the Pilot is specifically looking at the effect of the Common Agricultural Policy Reform on achieving the WFD objectives.

Work arrangements

The Environment Agency as competent authority charged with the Directives implementation in England and Wales will manage the project.

To prepare the Agency for implementation of the Directive the Agency has established a national Water Framework Directive programme to work with the EU and UK Government in interpreting the requirements of the Directive. It will produce generic guidance as well as co-ordinate and deliver the technical capability within the Agency for implementation of the Directive in England and Wales. The programme includes a number of projects, including the Ribble Pilot.

The Ribble Pilot will support the development of national guidance by providing a local test-bed basin.

Figure 39. Farming in Ribble Valley.

Figure 40. Demonstration project in Preston.

NGOs and stakeholders

Public participation by local stakeholders is seen as a key requirement for the successful implementation of the Ribble river basin project.

The project works closely with regional and local stakeholders. During the early stages of developing the 'prototype' River Basin Management Plan a vision for the future management of the Ribble Basin was produced by local stakeholders.

To help manage stakeholder engagement a stakeholder forum has been established, comprising representatives of all major local and regional stakeholder groups.

At a national level, the Department for Environment, Food and Rural Affairs (Defra) stakeholders Group will be used as the primary communication link for stakeholders.

Agricultural testing

The Ribble Pilot, during the second phase of the PRB exercise, will specifically focus and support work of the EU Strategic Steering Group on WFD and Agriculture.

During 2005-2007, the project will investigate how effectively changes to the Common Agricultural Policy, the introduction of Cross-compliance and measures under the England Rural Development Plan can reduce diffuse water pollution from agriculture and help meet the environmental objectives of the Water Framework Directive.

The Ribble provides the ideal study site for this work due to the diversity of farming activity within the basin, from intensive horticulture in the lowlands, to dairy farming in the lowland valleys to sheep grazing in the upper basin. We will also be carrying out studies in the Yorkshire Derwent catchment, an intensive cereal growing area east of the Pennines, to complement work in the Ribble.

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II.16. ZAGYVA-TARNA – HUNGARY (HU)

Where is it

In N-Central Hungary, the Zagyva River is a right side tributary of the Tisza River with a catchment area of approximately 5,700 km2. The Zagyva and its major tributary Tarna are originating from the northern valleys of the Mátra mountain and take their course southward along the foot of the mountain range. After their confluence the Zagyva reaches the Hungarian Plain and discharges into the Tisza at Szolnok. The Zagyva discharges into the Tisza river which in turn is a tributary of the Danube basin that dewaters into the Black Sea. The Zagyva-Tarna river basin is thus a sub-river basin of the international Danube river basin district.

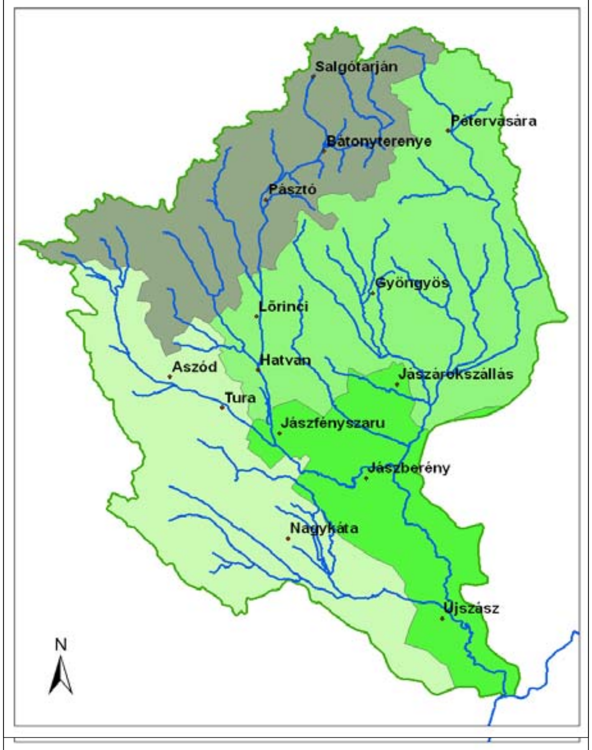

Figure 41.

Basin Description

In general, the catchment area can be sub-divided from the viewpoint of topography into three main sections. The upper section is the mountainous Matra mountain range with a number of water reservoirs located in the upper reaches. The lower section of the river basin is a flatland area with extensive agriculture and flood protection systems. There are 14 distinct flood plain areas in the water system, of which 12 are fully located in the river basin. There are 36 settlements located in these floodplains including major towns like Szolnok, Jászberény and Hatvan. There are no natural lakes in the catchment but 35 reservoirs have been constructed for flood control, drinking or irrigation water supply, and fish farming purposes. The total storage capacity is 31,9 million m^3. The largest reservoirs are the Köszörűvölgy, Csórrét and Hasznos drinking water reservoirs in the Mátra mountain.

Data Table

Total Catchment Area (Km^2)	5700 Km^2
Utilized Agriculture Area (UAA in % of above)	69 %
Population total	663 000 (118 inh/ Km^2)
Main land uses	Arable, pasture, forest, vineyards, rice
Water bodies that could be at risk of not meeting WFD requirements (in %)	N/A
Main agriculture pressures related to the above	Agriculture diffuse pollution and water use

Programmes

National Wastewater Management Programme; National Implementation Programme for individual Sewage treatments; Drinking water quality improvement programme; Protection Programme for Drinking Water resources; National Environmental Remediation Programme; Regional Flood Protection Plan.

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Link:

http://www.zt-euvki.hu/work/en/index.html; Article 5 report (National Report – in Hungarian):

http://www.zt-euvki.hu/Reports/External/VKI_JELENTES_HU_2005.pdf

PART III
SPECIFIC PRB TOPIC REPORTS

III.1. INTRODUCTION – PILOTING THE RIVER BASIN MANAGEMENT PLANS

The Water Framework Directive prescribes finalization of the River Basin Management Plan by the end of the 2009. At the beginning of Phase II of the exercise, each PRB designated the CIS activity/activities to which they would contribute among the following key topics:

River basin management planning: PRBs carried out preparatory work to reach compliance with Art. 13 of the WFD. The objective of the corresponding WG was to establish a work programme for the designation of the River Basin Management Plan, including the program of measures addressing all significant water management issues in the river basin district. Four PRBs has been involved in this activity: **Scheldt** (FR, BE, NL), **Odense** (DK), **Suldal** (N) and **Neisse** (DE).

Hydromorphology: the Hydromorphology activity on took from the work carried out for the analysis of pressures and impacts in the watershed according to Art. 5 of the WFD; activities within this activity focused on the identification of hydromorphological alteration which could lead hamper or impede altogether the achievement of the directive's goals. The PRBs contributing to the activities of this WG - **Suldal** (N), **Neisse** (DE) and **Weser** (DE), - tackled issues related to heavily modified water bodies (HMWB), designation and achievement of a good ecological potential (GEP).

Intercalibration & classification: Participating PRBs were **Jiu** (RO) and **Odense** (DK), contributing to the exercise with data. The main issue tackled within this WG A (ecological status) was the agreement between all Member States on the good status class boundaries.

Cost effectiveness analysis (CEA): the work on WG B (Integrated River Basin Management) on CEA focused on selection of cost-effective combination of measures to be included in the programme of measures. The PRBs **Odense** (DK), **Jucar** (ES), **Gascogne** (FR), **Harjiu** (EE), **Suldal** (N) and **Weser** (DE) provided examples of CEA for their basin and the specific pressures identified, with particular attention to the selection of mitigation measures.

Link with research: The PRB **Gascogne** (FR) provided some examples on the linkages between the implementation process and the water related research project in their watershed.

Priority substances and other pollutants: in accordance with article 16 of the WFD a number of priority substances have been identified from amongst those that present a significant risk to or via the aquatic environment. The priority substances identified also include substances designated as priority hazardous substances. The **Odense** (DK) PRB describes the measured required to ensure achievement of good chemical status.

Groundwater: during the years 2005-2006 activities related to the WFD and Daughter Directive implementation, were organized into 4 subject-areas: Monitoring, Protected Areas, Discharges, Status and Trends. Within the 6th Framework Programme, and parallel to these activities, the 'Background cRiteria for the IDentification of Groundwater thrEsholds' (BRIDGE) project was carried out with the aim of identifying a common methodology for the definition of thresholds introduced by the Daughter Directive. The **Tevere** (IT) PRB presents an overview of the activities carried out for the implementation of both Directives.

Reporting: The RBMP is the required instrument to guarantee the sustainable water use in each river district, to achieve a full public participation and to report to the EC on the successes achieved and the problems encountered during the WFD implementation process. To simplify and harmonize the process of reporting, enable to check compliance, and visualize the state of river basins with similar conditions in Europe, the data platform Water Information System for Europe (WISE) was developed. The **Ebro** and **Duero** (ES) PRBs provide some examples of the work carried out in the context of this WG.

PRB and Agriculture: The PRBs **Gascogne** (FR), **Guadalquivir**, (ES), **Odense** (DK), **Pandivere** (SL), **Weser** (DE), **Zagyva-Tarna** (HU), **Ribble** (UK), **Pinios** (GR) and **Neisse** (DE) contributed to the WG activities with the analysis of the links between agriculture and water resources. An important issue of discussion was about contributions of the Common Agricultural Policy to the achievement of the WFD objectives, and guidance on cooperation between authorities working on the WFD and the CAP.

III.2. RIVER BASIN MANAGEMENT PLANNING PROCESS, INCLUDING INTERNATIONAL COOPERATION

*This report was prepared by the Pilot River Basins **Scheldt** (FR, BE, NL) coordinator of the report, **Odense** (DK), **Suldal** (N) and **Neisse** (DE). More information about these river basins can be found in chapter II or at: http://ec.europa.eu/environment/water/water-framework/prbs.htm. The report addresses (one) specific aspect(s) of the common implementation strategy for the Water Framework Directive (Directive 2000/60/EC), as part of the second phase of pilot basin river activity.*

III.2.1. Introduction

In art. 13 of the Water Framework Directive (WFD) it is stated that a river basin management plan should be produced for each river basin district within the EU by the end of 2009. In the case of international river basin districts, the aim is to produce a single international river basin management plan.

In order to achieve the objectives of the directive, a program of measures should be established by the end of 2009 as well (art. 11). A summary of this program of measures should be included in the river basin management plan (annex VII).

When establishing river-basin management plans and programs of measures, Member States have to pass through a planning process, referred to as river basin management planning, both on the national and the international level (in the case of international river basin districts). The following intermediary products, which will ultimately lead to the development of a river basin management plan and a program of measures by the end of 2009, can be identified:

- ✓ a timetable and a work program for the production of the plan;
- ✓ an interim overview of the significant water management issues in the river basin district;
- ✓ a draft river basin management plan.

These intermediary products have to be the subject of a public consultation procedure (art. 14).

This key issue report describes how a number of pilot river basins organized their planning process in order to be able to produce a river basin management plan by the end of 2009 and which lessons they learned by doing this. A distinction is made between national and international river basin districts since planning processes as well as experiences are different.

Relevant requirements of the Water Framework Directive:

Article 11

*1. Each Member State shall ensure the establishment for each river basin district, or for the part of an international river basin district within its territory, of a **program of measures**, taking account of the results of the analyses required under Article 5, in order to achieve the objectives established under Article 4. Such programs of measures may make reference to measures following from legislation adopted at national level and covering the whole of the territory of a Member State. Where appropriate, a Member State may adopt measures applicable to all river basin districts and/or the portions of international river basin districts falling within its territory.*

(…)

7. The programs of measures shall be established at the latest nine years after the date of entry into force of this Directive and all the measures shall be made operational at the latest 12 years after that date.

8. The programs of measures shall be reviewed, and if necessary updated at the latest 15 years after the date of entry into force of this Directive and every six years thereafter. Any new or revised measures established under an updated program shall be made operational within three years of their establishment.

Article13

1. Member States shall ensure that a ***river basin management plan*** *is produced for each river basin district lying entirely within their territory.*

2. In the case of an international river basin district falling entirely within the Community, Member States shall ensure coordination with the aim of producing a single international river basin management plan. Where such an international river basin management plan is not produced, Member States shall produce river basin management plans covering at least those parts of the international river basin district falling within their territory to achieve the objectives of this Directive.

3. In the case of an international river basin district extending beyond the boundaries of the Community, Member States shall endeavor to produce a single river basin management plan, and, where this is not possible, the plan shall at least cover the portion of the international river basin district lying within the territory of the Member State concerned.

4. The river basin management plan shall include the information detailed in Annex VII.

5. River basin management plans may be supplemented by the production of more detailed programs and management plans for sub-basin, sector, issue, or water type, to deal with particular aspects of water management. Implementation of these measures shall not exempt Member States from any of their obligations under the rest of this Directive.

6. River basin management plans shall be published at the latest nine years after the date of entry into force of this Directive.

7. River basin management plans shall be reviewed and updated at the latest 15 years after the date of entry into force of this Directive and every six years thereafter.

Within the framework of the Common Implementation Strategy, a **guidance document** on the planning process was drawn up. This document provides recommendations on how to make the planning process operational and explains how to organize it.

III.2.2. Scheldt PRB: River basin management planning in an international context

The objective of the PRB-activity 2005-2006 for the Scheldt PRB was to agree on a work program for the elaboration of the international river basin management plan (IRBMP) for the Scheldt, to define the significant water management issues that are of common interest in the entire river basin district and to draw up an annotated table of contents for the IRBMP. These actions were carried out as part of the Scaldit project (end date: December 2006) and within the framework of the International Scheldt Commission, in which all Scheldt riparian states/regions are represented. The focus of the activity was the cooperation between different member states/regions in an international river basin district.

The production of an international river basin management plan for the Scheldt was already envisaged by the Scheldt Treaty of 2002 (Treaty of Ghent, art. 2) and is one of the main objectives of the International Scheldt Commission for the years to come. Therefore, the first preparatory steps to the production of this plan were also included as an action in the Scaldit project (Action "Up to the IRBMP"), by means of elaborating a work program and a table of contents for the Scheldt IRBMP.

Article 13 of the WFD could be read as stating that the riparian states should produce one sole RBMP for the whole river basin district. In several international districts, discussions have taken place on the level of detail and scale of the RBMP. In all cases, the discussions lead to the development of plans at different scales; a 'roof' or high scale plan dealing with issues at the international river basin district, and plans at lower scales. The latter can be the national scale, but for instance in the case of the River Rhine, the highest but one level is the 'working area', still crossing national borders.

In the case of the Scheldt, the partners work together in the International Scheldt Commission, focusing on the development of an international river basin management plan. The coordination of the international plan with the plans at national and regional levels will be done by each of the partners individually.

The work program for the elaboration of the IRBMP for the Scheldt was integrated into the work plan for the International Scheldt Commission for the period 2005-2009. This means that the different steps that are necessary to draw up the river basin management plan are defined as actions to be undertaken by the working and project groups of the International Scheldt Commission.

One of the problems we had to solve in order to be able to define a work program was the fact that the different riparian states/regions of the Scheldt river basin district apply different timetables for the elaboration of their national or regional river basin management plan. Some regions work with an advanced timing compared to the WFD timing, whereas other regions follow the WFD timing. To get around this problem, we defined the work program for the IRBMP according to a stepwise approach. In this way, all regions can optimally respect their own time tables for their national/regional management plans and at the same time they can elaborate together an international river basin management plan (roof report) according to the WFD timing.

In practice, this means that prior to the draft IRBMP, which has to be ready by the end of 2008, two rough drafts of the IRBMP will be drawn up, at the time that the delegations that work with an advanced timing have the first draft of their river basin management plan available. The other delegations will make an effort to deliver as much information as they have and as they can at that moment for these rough drafts of the IRBMP. In this way, the rough outlines of the IRBMP will already be decided on, so that the delegations with the advanced timing can take them into account in the further development of their national/regional RBMP. Finally, by the end of 2009, the definitive version of the IRBMP will be ready for approval.

A following step towards the production of a river basin management plan was the definition of significant water management issues on the level of the international river basin district. These were defined on the basis of the roof report (art. 5 analysis) for the Scheldt IRBD. This means that it concerns issues that constitute a problem in terms of water management in each of the riparian states/regions. These significant water management issues will form the basis for the production of the IRBMP for the Scheldt.

Following issues are considered as significant water management issues in the Scheldt IRBD: Surface water quality, hydro morphological changes, sediments; Groundwater vulnerability; Scheldt-specific pollutants; Economic analysis; Flood and drought prevention management; Governance; Data, measuring methods and assessment methodologies.

This is already an example of the stepwise approach as described above because the water management issues on the international level were defined before they were defined on the national/regional level in some of the riparian states/regions. The international implementation is in this way ahead of the national/regional implementation.

A brochure on these water management issues is available (Dutch, French and English) and can be downloaded from the Scheldt website (**http://www.scaldit.org**).

Finally, the Scheldt riparian states/regions drew up an annotated table of contents for the international river basin management plan, which includes following chapters: Introduction – elaboration process; Presentation of the international Scheldt RBD; International coordination of the national/regional monitoring networks; Coordination of environmental objectives; Coordination of the programs of measures; Register of protected areas; (Coordination of activities for preventing the effects of floods and droughts); Public information and consultation; Annexes: national/regional RBMPs, competent authorities, references.

III.2.3. Neisse PRB: "Programme of Measures in an International Context"

III.2.3.1. Foreword

Due to a delayed start of the project, the following descriptions do not show any results of the project work but do explain the strategy and methodical approaches for the implementation of the water frame work directive (WFD) that are being initially discussed in the PRB-project of the tri-national catchments area of the Lusatian Neisse. That means they are not yet finally inter-coordinated with the project partners nor do they have an authoritative official character within one of the concerned EU-member states or German federal states. Nevertheless these strategies and methods are meant as innovative and practical proceeding proposals for the next steps of the WFD-implementation process in the trans-national PRB Lusatian Neisse.

III.2.3.2. Program of Measures

Start of the PRB Neisse project was delayed, thus the actual status of the planning procedure for the program of measures is provisional and remains to be tested. The analysis of risk assessment conducted during the first phase of the PRB-Neisse project (Fritzsche et al., 2005) revealed that without mitigation measures the environmental goals of the European WFD couldn't be achieved in the catchment of the Lusatian Neisse. The development of a Program of Measure (PoM) as an integral part of the river basin management plan (RBMP) is demanded by article 11 of the WFD. The challenge for each river basin management plan is now to plan and perform measures that ensure to achieve the conditions of a good ecological status of freshwaters:

- ✓ for catchments that cover areas of several hundreds to thousands of square kilometers,
- ✓ with moderate and economical costs,
- ✓ by considering the interests of different stakeholders.

This planning task becomes even more complex, if the iterative character of the WFD is taken into account. The development of the PoM is an iterative process not only because the time schedule for the WFD prescribes a regular revision of the RBMP (figure 2) but also for the reason that:

- ✓ Water body delineation and HMWB-definition are actually provisional
- ✓ Results of the biological assessment to rate the present ecological status of water bodies are not available yet
- ✓ Pressure-impact-relations are not always well understood
- ✓ Some measures (e.g. treatment plants) have a long life cycle and can be very costly
- ✓ System changes (climate change, demographic change) are likely to occur within the next decades

Based on the results of several research projects (DAYWATER, WSM300), an integrated planning method has been developed which fulfill the requirements mentioned above. Core of this planning method is a Decision Matrix that lists different possible measures or combination of measures (scenarios) versus several criteria, also called indicators. This matrix is not only a way to present the results of the planning process, it also offers a roadmap for a transparent decision making process. This method will be tested within the next phase of the PRB Neisse project. In the following chapter the different steps necessary to setup a Decision Matrix will be explained in detail.

III.2.3.3. Setting up a Decision Matrix

Development of a decision matrix (see figure 2) requires 4 major steps:

- ✓ Agreement on a set of indicators representing the planning goals
- ✓ Development of scenarios (set of measures)
- ✓ Quantifying the impacts of the measure (or combination of measures) regarding each indicator
- ✓ Find the best solution among the different scenarios

In contrast, designing a measure like a wastewater treatment plant to achieve the good ecological status is not directly possible. Instead, criteria based on immission data that represent the ecological status of a water body have to be defined. Examples for such immission-based criteria are ammonium concentration, biological oxygen demand (BOD) or peak discharge with a one-year return period as an indicator for hydraulic stress. Indicators representing the ecological status of water bodies are type-specific and in Germany often not pre-setted by law.

In addition, other criteria representing the various interests of numerous stakeholders, e.g. flood protection, recreational value or fishing possibilities, should be considered in the planning process. To ensure an acceptance for the result of the planning process, stakeholders should be involved in the selection process of indicators, as early as possible (figure 4).

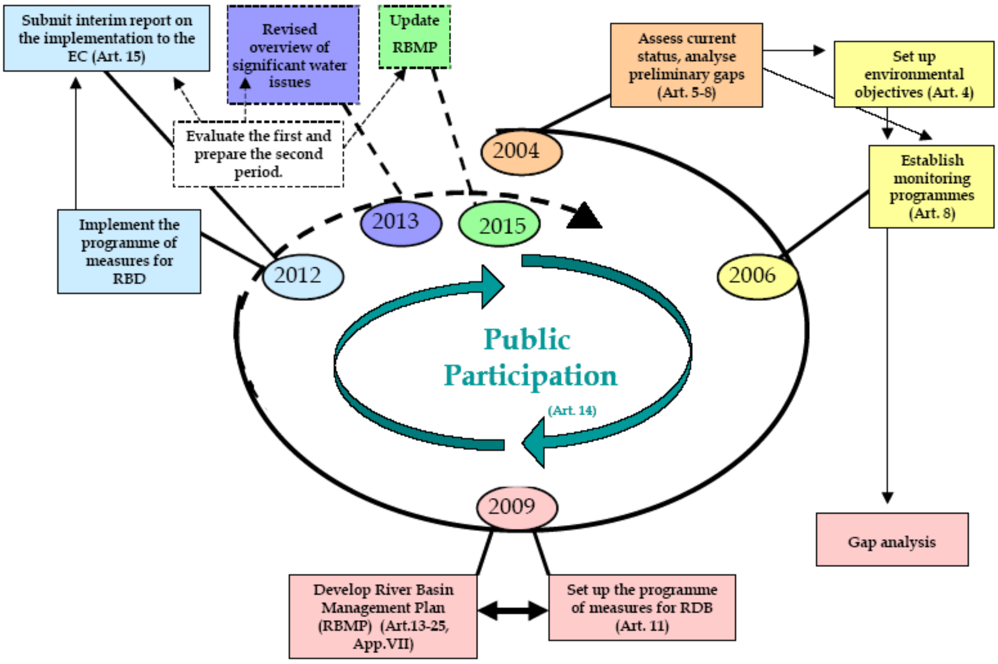


Figure 1. Iterative character of the WFD, CIS Guidance on the planning process (2003).

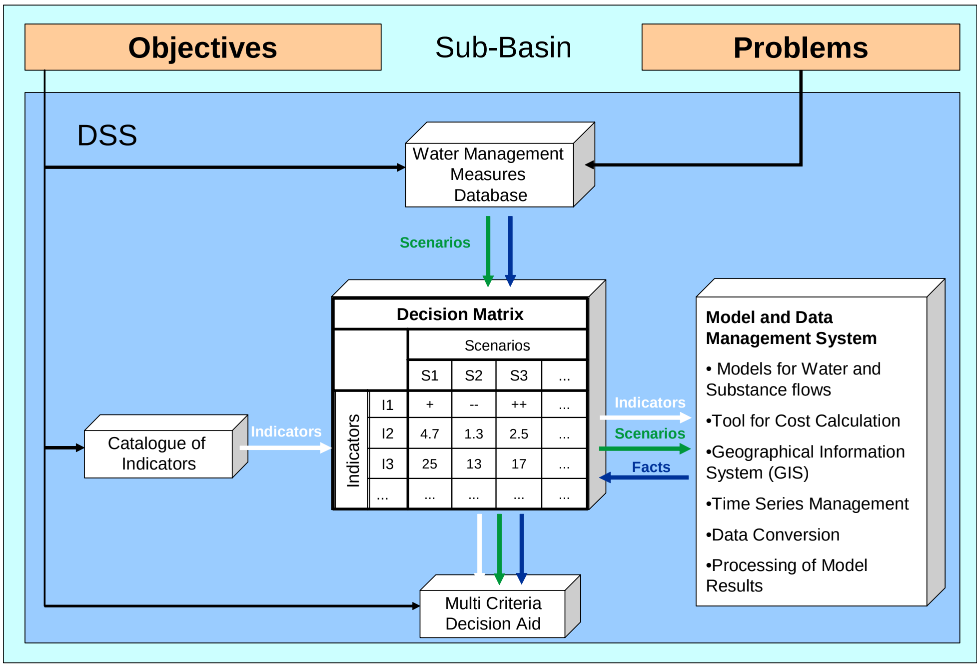


Figure 2. Scheme of a decision matrix.

III.2.3.4. Development of scenarios (set of measures)

Second step in setting up a decision matrix is the development of planning scenarios. Based on the pressure-impact-analysis, measures that can possibly reduce the impact of certain pressures or disturbances are selected. Databases with fact sheets can be a valuable tool to get an overview of the large variety of possible measures. The number of possible measures is usually larger than one would expect. For example, to reduce emissions from combined sewer overflows (CSO) four general solutions are available:

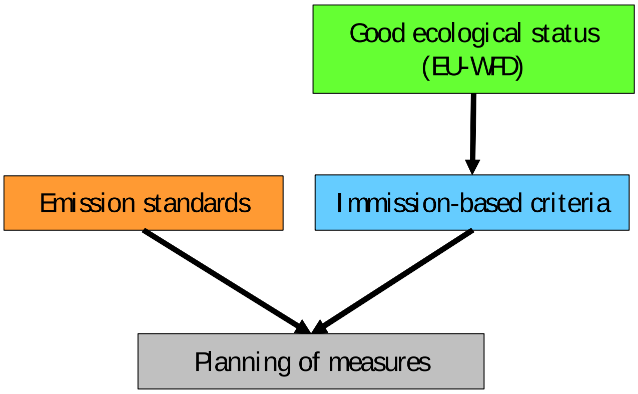


Figure 3. Combined approach of the WFD in Germany.

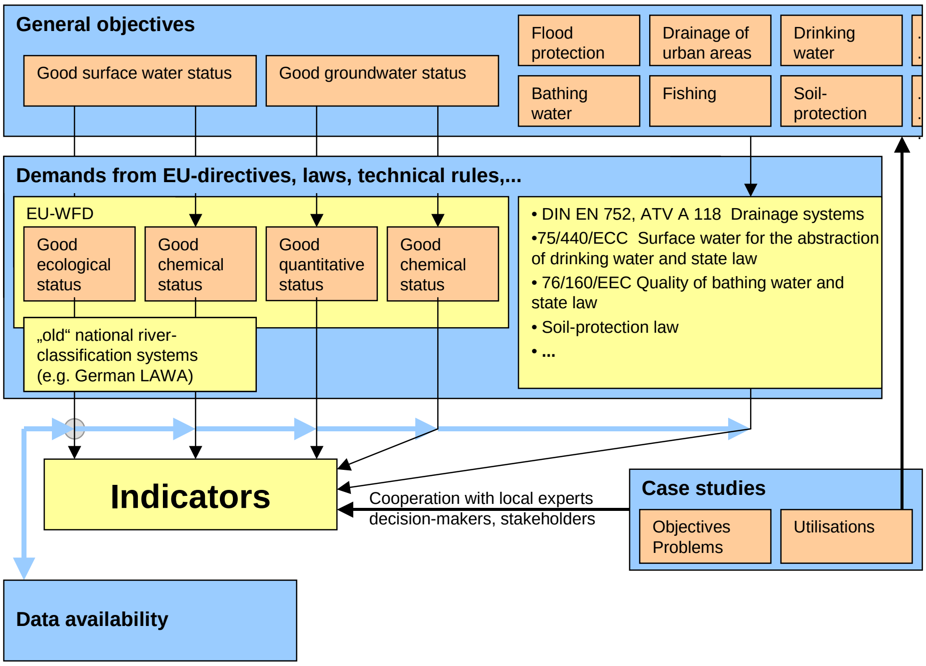


Figure 4. Development of a set of indicators.

- ✓ Enlargement of treatment capacity of the wastewater treatment plant (WWTP)
- ✓ Storage of combined sewerage (e.g. in CSO-tanks) and treatment of the WWTP after the rain event.
- ✓ Treatment of the overflow on-site e.g. in soil filter ponds
- ✓ Reduction of storm water runoff in the combined system by disconnection

As the effects of these alternative solutions on the various indicators are different, it is not sufficient to simply rate the reduction of CSO as a measure.

It is essential not to exclude measures that seem to be of low efficiency at an early stage of planning for two reasons. First, due to the complexity of the system the effect of measures sometimes can be underestimated and not been precalculated even by experienced planners. Secondly, it is important for the decision making process to take along 'weak' solutions simply to demonstrate that they have been considered and finally rated as inappropriate to achieve the pre-setted goal.

To develop catchment-wide scenarios a tool called FLEXT (Jin et al., 2005) is used. With this tool – a combination of an expert system with GIS - maps showing the potentials for measures are produced. So far FLEXT has been used successfully to identify measures for storm water management in urban areas (figure 6) and for the potential of conservational tillage in agricultural areas to reduce the nutrient pollution of water bodies. Stakeholders should be involved in the scenario development for the same reason as formerly explained for the selection of indicators.

Quantifying the impacts of the measure regarding each indicator.

The third and most time-consuming step is the identification and quantification of the impacts of every possible measure and combination of measures regarding each indicator. For this task usually simulation models (e.g. rainfall-runoff-models, pollution load models, water quality models) are used. The decision matrix asks for aggregated values, which have to be calculated from the extensive modeling results. GIS and time series management tools are helpful for this task. Nevertheless, the use of such models is common standard in Europe.

For some indicators like the Net Present Value (NPV, indicator for life cycle cost) other tools are available. Even for 'weak' indicators like the recreational value approaches are available (Kaiser, 2006).

While selection of indicators and scenario development asks for a stakeholders involvement, the step of quantifying the impacts is mainly expert work. Especially modeling of scenarios and calculation of costs are technical-scientific work, which requires a lot of expertise.

Find the best solution among the different scenarios.

Although the decision matrix is never final – developing a PoM is an iterative process that must be steadily adapted to changed frame settings making some measures unnecessary due to the improvement of the ecological status of a water body achieved by other measures or environmental changes – at some stage of planning it must be preliminary completed to display all the impacts of the selected measures for the set of indicators.

This provides a good basis for a decision. A scenario that is optimal for all indicators will rarely occur, but rather each scenario has advantages and disadvantages corresponding to each indicator. This makes it difficult to make a decision for a special scenario and also to explain such a decision to parties with contrasting opinions.

Nevertheless mathematical tools to find optimal solutions – or to exclude 'weak' solutions – are available. These multi-criteria decision aid methods determine a ranking based on the indicators' values and weightings. A form of MAVT[4] was identified to be suitable and has been implemented into an EXCEL application (Fig. 7). Sensitivity analysis functionality has been added to support the discussion about weightings and value functions.

[4] MAVT: Multi Attributive Value Theorie.

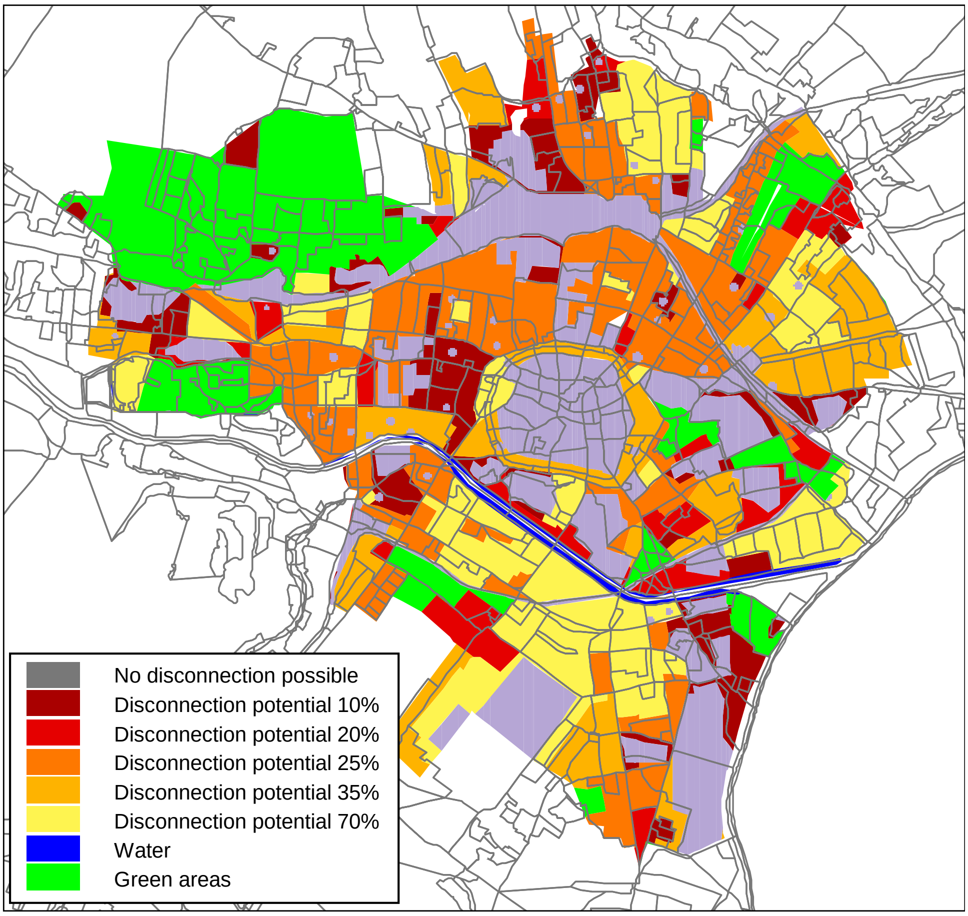


Figure 5. Potential map for storm water management measures in Zittau (Sieker and Wilcke, 2002).

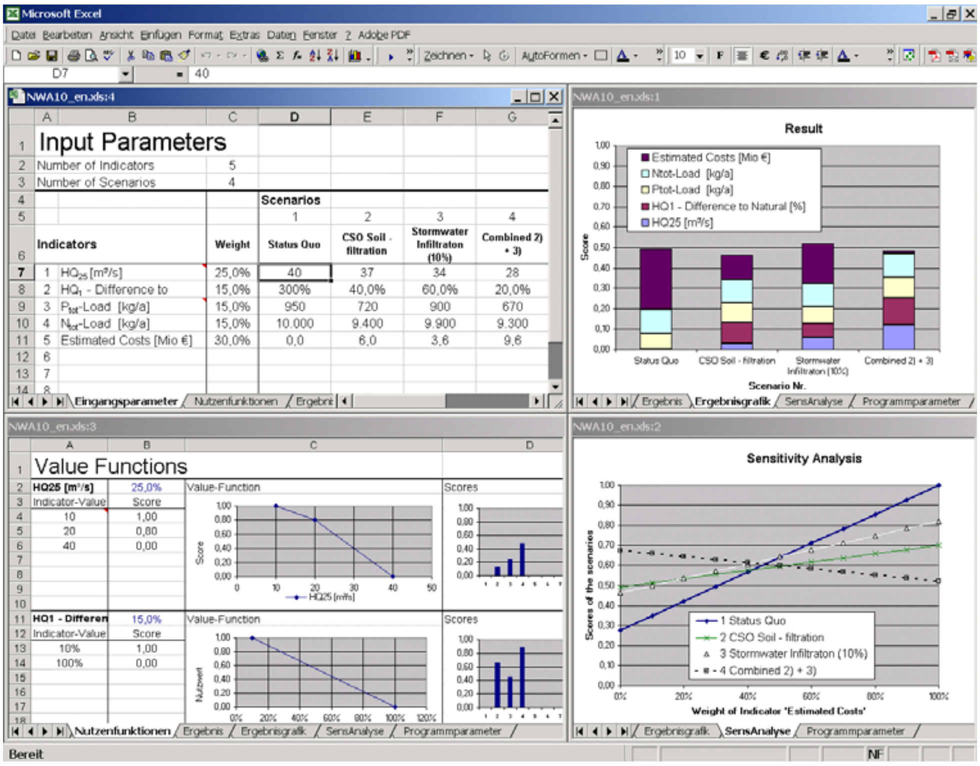


Figure 6. Decision matrix, MAVT and sensitivity analysis.

References

CIS Guidance Document IMPRESS (2003): Guidance Document on the Analysis of pressures and impacts (signifikante Belastungen, Prioritäre Stoffe), CIS Working Group 2.1, verfügbar unter www.wasserblick.net

CIS Guidance Document Planning Processes (2003): Guidance Document on Best practices in River Basin Planning (Methoden für die Flussgebietsplanung), CIS Working Group 2.9, verfügbar unter www.wasserblick.net

Fritzsche B., Gondlach S., Sonntag H., Sieker H., Halle M., Podraza P. (2005): Erprobung innovativer Vorgehensweisen bei der Erstellung des Bewirtschaftungsplanes Oder/Lausitzer Neiße gemäß EG-Wasserrahmenrichtlinie, Forschungsbericht, Umweltbundesamt, FKZ 203 22 281

Jin, Z., F. Sieker, S. Bandermann and H. Sieker (2005): Development of a GIS-based Expert System for on-site Stormwater Management, 10th International conference on Urban Drainage (ICUD). Copenhagen.

Kaiser O. (2006): Bewertung und Entwicklung urbaner Fließgewässer, Culterra - Schriftenreihe des Instituts für Landespflege der Universität Freiburg, Heft Nr. 44

Peters, C., Sieker, H., Jekel, M. (2003): A Decision Support System for Integrated Water Resource Planning in Small Sub-Basins. In Proc. of the Second World Wide Workshop for Young Environmental Scientists, Vitry sur Seine - France, 14-17 May.

SMUL (2005): Bericht über die Umsetzung der Artikel 5 und 6 sowie die Anhänge II, III und IV der Richtlinie 2000/60/EG im Bearbeitungsgebiet Lausitzer Neiße

Schröter, K. (2004) Development of a Decision Support System for Integrated Water Ressources Man-agement in Intensively Used Small Watersheds. In Proc. of the 6th International Conference on Hydroinformatics, Liong, Phoon & Babovic (eds).

Sieker F., Wilcke D. (2002): Innovativer Ansatz eines vorbeugenden Hochwasserschutzes durch dezentrale Maßnahmen im Bereich der Siedlungswasserwirtschaft sowie der Landwirtschaft im Einzugsgebiet der Lausitzer Neiße", Abschlussbereicht zum DBU Projekt AZ 15877 gefördert durch die Deutsche Bundesstiftung Umwelt, Osnabrück

III.2.4. Odense PRB: River basin management planning in a national/regional context

The objective of the concluding part of the Odense PRB activity was to create a provisional River Basin Management Plan for the Odense PRB in autumn 2006 (Odense RBMP), ensuring that the common goal of obtaining 'good ecological and chemical status' of all surface waters and 'good quantitative and chemical status' of all ground water in 2015 will be reached. The planning process is conducted in close cooperation with the three advisory boards (national, regional and technical) formed in the first part of the PRB activity. Due to the ongoing structural reformation in Denmark, where the present water authorities will cease to exist by January 2007, the WFD-related planning process will involve new regional and national authorities.

In Odense RBMP, the specific programs of measures addressing each water category (including wetlands), and handling all main pressures (pollution and physical) in the Odense PRB will be integrated, and economic analyses of cost-effectiveness of the proposed measures will be performed. The synergetic effects of combining the measures needed for each water category and the economic benefits of implementing the measures in a coordinated program of measures and management plan will be elucidated.

The work is performed on the basis of findings in the Article 5-report for Odense PRB (Fyn County 2003), where the significant water management issues and main pressures in this specific river basin were identified. The following water management issues are considered significant in the Odense RBD:

- ✓ Development of WFD-relevant reference conditions, classification of water quality, and quantitative linkages between pressures and impacts;
- ✓ Surface water quality in terms of eutrophication, impact of hazardous substances, and physical impact;

- ✓ Hydromorphological changes due to river maintenance and land reclamation (primary agricultural purposes) of wetlands, lakes and coastal waters, obstructions of fish migration, and water abstraction;
- ✓ Groundwater vulnerability due to water abstraction and pollution;
- ✓ Integration of additional measures needed for internationally protected areas;
- ✓ Development of adequate monitoring programs and assessment methodologies;
- ✓ Economic analysis of cost-effective measures;
- ✓ Public participation and stakeholder analysis.

Secondly, the RBMP-work is based on the specific programs of measures elaborated in the second phase of the Odense PRB-project, for each water category

- ✓ wetlands,
- ✓ rivers,
- ✓ lakes,
- ✓ coastal waters,
- ✓ groundwater,
- ✓ and addressing the main polluting and physically impacting sectors individually:
- ✓ agriculture,
- ✓ point sources (waste disposal sites, households and industries (urban areas)),
- ✓ point sources - scattered settlements,
- ✓ fishery, harbor maintenance and navigation a.o.

Cost-effectiveness of the individual measures was analyzed, and a cost-effective integrated program of measures necessary to reach the aim of 'good status' in 2015 for each water category was described.

Finally, a table of contents for the River Basin Management Plan was drawn up and agreed by the stakeholders of the project. Water Management Plan - table of content:

- ✓ Preface
- ✓ Description of geographical area
- ✓ Monitoring program
- ✓ Environmental objectives
- ✓ Risk analysis - environmental state and development
- ✓ Measures to fulfill objectives - effects and costs
- ✓ Cost efficiency analysis
- ✓ Public participation
- ✓ Time table on implementation of measures

III.2.5. Suldal PRB: The River Basin Management Plan – coordination with existing planning procedures

Note: The Suldal PRB has not yet initiated a planning process in the specific catchment due to unforeseen delays in the formal adoption of the WFD in Norway. However, various challenges and dilemmas, which concern river basin planning, have been discussed as part of projects with special focus on river basins heavily regulated by hydropower.

The river basin management plan will not be legally binding in Norway. However, the plan will be approved by the County Council and is directional for executive sectors on how to identify environmental objectives and implement measures to fulfill the objectives. The river basin plan will to a large extent comply with the existing planning procedures for a Regional Plan pursuant to the Norwegian Planning and Building Act. The river basin management plan will be subject to well-established procedures on public consultations and will be approved by the County Council and later by the national Government.

In addition, the river basin management plans need to be coordinated with the existing plans which include environmental issues. For the hydropower sector, various types of plans provide restrictions on hydropower development. The National Protection Plans were developed to protect complete watersheds to maintain the environmental diversity stretching from the mountains to the fjords. By these plans, 341 Norwegian watercourses have been protected against hydropower development.

The purpose of the so-called Master Plan for Hydropower is to plan and license hydropower development at a broader scale, including consideration of socioeconomic and environmental issues. The plan includes many strategic elements comparable to a SEA. Altogether 310 hydropower schemes larger than 5 GWh/year were considered with respect to project economy, including possible impacts on the regional economy, and conflicts with other user- and protection interests.

A new type of plan called Regional Plans for Small Hydropower is now under preparation since the interest for small hydropower (<10 MW) is growing rapidly. In order to ensure better planning and handling of cumulative impacts arising from several separate projects within a limited area or watershed, the Government has called for development of master plans for small hydropower plants at the regional level. The regional county administrations will coordinate the planning process pursuant to the Planning and Building Act and the County Councils will approve the final plans. Mechanisms for proper coordination with the RBMPs under the WFD will be included.

III.2.5.1. Organization at regional level

A new body, the Water Regional Committee, with members from already existing regional authorities will coordinate the process of developing the River Basin Management Plan (RBMP). The County Governor will facilitate the process and will be the regional authority in charge. It is strongly recommended to establish a Reference Group to assist the Water Regional Committee. This reference group will be comprised of representatives from the local administrative level (municipalities), all relevant users groups and NGOs.

III.2.5.2. Organization at local level

The Water Regional Committee will also be in charge of coordinating the characterization of all the water bodies. Based on the characterization, the Committee will identify "Local Measure Planning Areas". If necessary, local working groups will be established. These groups will be led by local municipalities and involve relevant user groups and NGOs. In some areas in Norway, such working groups have already been established to combat environmental water problems like pollution and encroachments. These local plans will feed information on local problems and assessments of potential measures (based on costs and effects as far as possible and appropriate) into the regional RBMP. The RBMP will also give advice on which "local measure planning areas" that are to be identified in the next planning cycle.

III.2.5.3. Implement measures pursuant to sector legislation

The objectives and measures that are described in the RBMP will give strong guidance on how the various sectors implement measures based on existing laws. The planning of measures undertaken at both local and regional levels will be of preparatory nature and will thus facilitate the further decision-making process in implementing specific measures.

III.2.5.4. Draft procedure of the development of river basin management plans and implementation of measures

✓ The characterization according to Article 5 in the WFD will provide the basis for all water related planning. In Norway, the characterization results have been collected and analyzed by using a GIS tool. The local level (municipalities) will be given access to the characterization data and will be able to make revisions based on local knowledge.

✓ The relevant authorities and user groups will work together to make a local action plan based on local problems and local requests for the utilization of the river basin. Local action plans will not be prepared in all catchments, but limited to areas where specific water problems have been identified. See figure 7 referring to local action plans for river basins 1, 2 and 3.

✓ The affected municipalities will be the prime movers at this stage. Various river organizations already exist in Norway and new "groups/projects" will be established as part of the RBMP process. Potential measures should be discussed and, where possible effects and costs should be estimated. One challenge is to avoid duplication of later work that will take place as part of the executive work to implement measures. It is also important to avoid conflicts regarding roles as the same organizations and authorities may be involved in local planning, regional planning as well as in the final implementation stage.

✓ The next stage is the preparation of the river basin management plan at the river basin district level. The regional program of measures included in this plan will be based on all the local plans from the "planning measure areas" within the river basin district. These local plans will be compiled into one regional plan and priorities between areas and sectors will need to be assessed. The river basin district authority (Water Regional Committee) will also need to take national policy into account and suggest environmental objectives and assessment of disproportionality of costs.

✓ Since the program of measures is not legally binding it will thus not have the possibility to decide which abatement measures that are to be implemented. The final decision is left to the sector authorities who are in charge of the necessary legal, administrative and economic instruments to take action. The RBMP is, however, an important guidance and contains a lot of information that will make the implementation work easier.

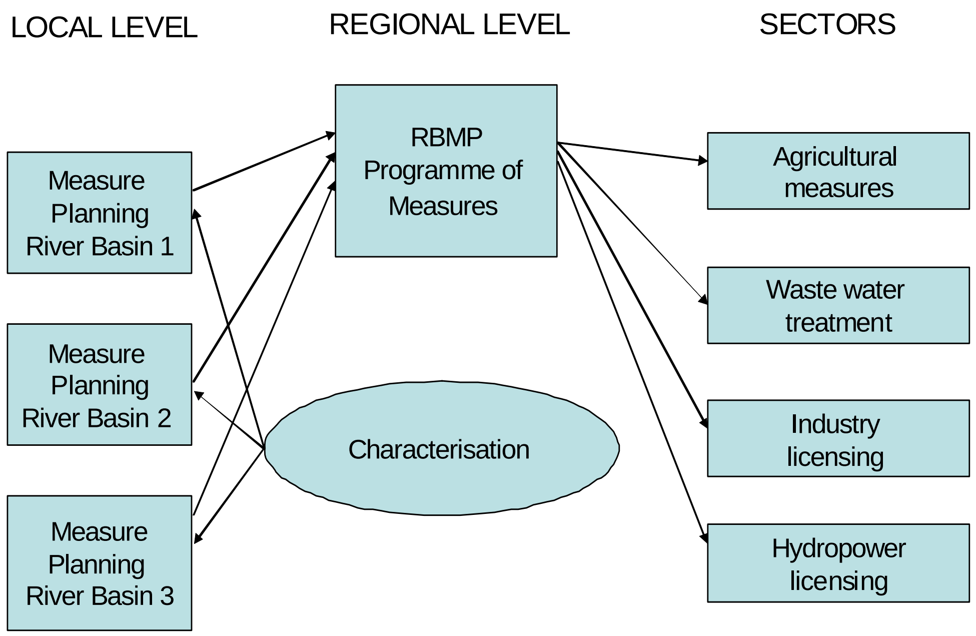


Figure 7. Principal drawing of levels involved in planning and implementing measures to fulfill the environmental objectives.

III.2.6. Discussion

From these four case studies, it can be concluded that:

✓ The approach for the development of a river basin management plan is more or less the same in the different PRBs, regardless of their international (or not) character. This is quite logic since the WFD prescribes a number of intermediary products. In Suldal PRB, the importance of coordination with existing plans and processes has been stressed. Moreover, it appears that the legal status of the programs of measures will vary: in some cases, they will be directional; in other cases they will be (partly) legally binding.

✓ There are great similarities between the significant water management issues in the Odense PRB and in the Scheldt PRB, in spite of the big difference in scale between both PRBs. This indicates that the major problems and challenges in water management are largely the same throughout Europe. This became already clear in the document "Information exchange on WFD key issues and research needs" of CIS WG B (2005).

✓ Both Suldal and Odense PRB will draw up a sector-oriented program of measures, which offers the advantage of being more transparent in respect of the individual sectors.

✓ To work within official structures is considered important both in Scheldt and Suldal PRBs.

III.2.7. Conclusions and recommendations

III.2.7.1. Conclusions and recommendations International pilot river basins – Scheldt PRB

Cooperating in an international river basin district with the aim of producing an international river basin management plan is not an easy task because a lot of (sometimes conflicting) interests are at stake. It is a costly and time-consuming occupation, requiring a lot of negotiations and compromises. It should be recommended to start as early as possible with the preparation of the international river basin management plan, to work within an official structure (international river commission) and to work with clear mandates and clear deadlines. It is also recommendable to let a number of intermediary products (e.g. a table of contents for the IRBMP) endorse by the decision makers, in order to have a clear basis from which to start from. Within the Scheldt PRB, e.g., such intermediary products are submitted to the Heads of Delegations of the International Scheldt Commission for approval. Once approved, these products serve as terms of reference for the working and project groups of the International Scheldt Commission.

Another point of interest is that coordination within international river basin districts should not necessarily lead to the harmonization of methods, data, etc. Indeed, every member state has its own (national) methods and own way of collecting data and this should be respected, all the more because most member states belong to more than one international river basin district and it is quite clear that it would be impossible to use other methods or data formats in each of these international river basin districts. However, even when using different methods and data formats, it is possible to make these methods and data comparable (this is e.g. also the central idea of the European intercalibration exercise). Comparability is hence a much more realistic and achievable goal than harmonization.

When working together, it is also important to get to learn each other organizations, cultures, methods, histories, mutual differences etc. in order to better understand each other. Mutual understanding is an important condition for the cooperation to be successful. Therefore it is important to meet on a regular basis because this creates an atmosphere of confidence. However, this requires additional financial and human resources, all the more when using the different languages spoken in the IRBD as working languages, because in that case all the meetings have to be interpreted and all the documents translated. Choosing this option offers the advantage of a greater equality between the different member states, because they all have the right to express their selves in their own language. It is, however, a very expensive option. Whatever cooperation modality is chosen, it is clear that the coordination of the WFD in international river basin districts is a time and resource consuming process. The necessary financial resources can be provided by the Member States their selves, which is not obvious, because most Member States are already facing limited resources for the implementation of the WFD, even within their own country. Besides, it is not always easy to convince policymakers of the surplus value of transnational cooperation, even if the WFD strongly urges the Member States to do it. In order to raise the (existing) international cooperation to a higher level and to give it a clear added value, Member States could also apply for European funds.

III.2.7.2. Conclusions and recommendations National pilot river basins – Odense PRB

The time schedule for implementation of the WFD is very tight, and demands precise allocation of the resources necessary to achieve the defined aims. Furthermore, integrated management strategies are a prerequisite to develop a coherent program of measures, addressing all relevant pressures.

1. Integrated management strategies

Developing a cooperation structure between the different relevant authorities on regional and on national level in the Odense PRB was a very time- and resource-consuming process, so it was of utmost importance to start this cooperation early in the process. During this process, the different authorities got acquainted with each other, and developed a common frame of understanding and a set of generally accepted terms of reference.

Another issue was the integration of stakeholders and NGOs in the process. Stakeholders and NGOs representing industry and agriculture have a much stronger economic foundation for their activities compared to e.g. nature conservationists and thus have better possibilities to influence the negotiations and the final outcome of the process. A balanced reflection in program of measures of the different stakeholder inputs thus becomes an even more important task for the authorities.

There is also an urgent need to strengthen the integrated management strategy in the river basins in order to characterize all-important pressures and develop efficient and coherent programs of measures, addressing all-important pressures on the aquatic environment. The preliminary analyses of pressures and cost-effectiveness point at very important synergetic effects. When solving problems related to e.g. the nutrient pollution of the marine areas by appointing areas for intensification of agriculture activities, the same areas may serve as buffer strips for lakes and watercourses, and may also add to improve the conservational status of Nature-2000-protected areas and other nature areas. The same synergy will be obtained for the economic costs of implementing the relevant measures.

Considering the demands from other relevant EU-directives encompassed by the WFD, e.g. the Nitrates, the Urban Waste Water, the Natura-2000-directives etc, should also be an integrated element in the planning of program of measures and RBMPs from the beginning of the process, and focuses even more on the demand of cooperation between different authorities.

2. Risk analysis and development of quantitative relationships between pressures and impact

The manmade impact, by industry and especially by agriculture, of the Danish aquatic environment is widespread and severe, and has been frequently reported, at the latest in the risk analysis performed by the Danish counties in spring 2006, where almost all of the coastal waters, 75% of the lakes, and 69% of the rivers are considered to be at risk of not fulfilling 'good ecological quality' in 2015, on a national level. In Odense Pilot River Basin, the results of the risk assessment were parallel to the national results, except for rivers, where only 4% were assessed as not being at risk. Around 50% of the ground water resources were at risk. Identification of the most important pressures is thus not a difficult task, while developing clear quantitative relationship between WFD objectives, operational environmental quality objectives for the water bodies, and the associated maximum permitted pressures, showed out to be a process arising a very intensive debate, both scientifically and economically, in all the Odense PRB working groups. These relationships, however, are the basis for dimensioning the program of measures in the river basin management plans, so these preconditions have to be present early in the planning process as a basis for involving the public in the choice of measures to fulfill the environmental quality objectives.

3. Cost-effectiveness

Cost effective analyses point out, that a program of measures fulfilling the WFD objective of the Odense fjord can be developed within reasonable economical frames. The need for measures and the effects on the other parts of the aquatic environment, e.g. ground water and fresh waters, however, is not included yet, but will be analyzed in the next step of the process. This program of measures reduce the annual nitrogen input to the fjord by 1,000–1,200 tonnes per year, corresponding to a load reduction of the order of magnitude needed to fulfill the objective of good status. In general, re-establishment of wetlands and reduced fertilization norms are the most effective measures if large reductions in loading are to be achieved. Catch crops are also effective and have a substantial effect, while reduction of livestock production in the catchment may not be necessary. The total budgeted costs for this scenario on agricultural measures are 4 million EURO per year. These costs can be compared to the cost of already implemented measures on sewage treatment within the catchment, which is 40 million EURO per year, and the costs of already implemented measures reducing nutrient loads from agriculture, which is about 1 million EURO per year.

4. Protected areas

In areas encompassed by other protective directives, e.g. areas designated as Natura 2000-areas, further measures will in many cases be necessary to ensure the fulfillment of the specific requirements of these directives, e.g. "good conservational status" for the Habitats Directive.

5. Monitoring programs

The development of an appropriate monitoring program is also a demanding task. The existing monitoring programs reflect primarily the needs of the sector-defined handling of pressures and impacts. A higher level of integration of the different monitoring programs will be necessary to follow the effects on the aquatic environment of the integrated programs of measures. The experiences from the Odense PRB point out, that development of such monitoring programs is quite challenging and time-consuming, and demands a close cooperation between all authorities involved from an early stage in the process.

6. Public Participation

Public participation is of key importance to the preparation implementation and success of RBMPs, but is also very time- and resource-consuming. Enough resources should thus be allocated to this specific activity at an early stage in the process. As the time schedule of the WFD is very tight, the early involvement of the public and the stakeholders in the process is vital to ensure its success:

- ✓ Early identification of stakeholders promotes public participation
- ✓ Clear mandates and a transparent management process promote stakeholder- and public participation
- ✓ Public participation should be planned as an integral part of river basin management from the start of the planning process
- ✓ The authorities must be aware of different possibilities that stakeholders and the public have to participate due to differences in financial and human resources.

III.2.7.3. Conclusions and recommendations National pilot river basins – Suldal PRB

1. Integrate WFD planning with existing planning procedures

The coordination between existing local, regional and national authorities is crucial to ensure an effective planning process. The WFD should be integrated as much as possible in already well functioning processes instead of being treated as a separate planning issue. This will ensure that all sectors take environmental objectives into account as early as possible in their planning for the future.

2. Decisions on who does what

Discussions on "who does what" will often delay processes and undefined areas of responsibilities may also lead to less cooperation, involvement and enthusiasm. It is therefore important to make decisions as early as possible on who is responsible for what as well as clear and well-communicated ground rules.

3. Develop guidance on environmental objective setting and planning of measures at both local and regional level

Even though a wide range of, often comprehensive, guidance documents have been produced as part of the common implementation strategy, there is still a need for simple guidance in native language. Norway is now in the process of developing guidance documents on planning of measures at regional and local level with "Water Regional Committee" and municipalities as target groups. Experiences from already undertaken projects show that the methodology needs to be very simple in order to ensure that non-technical staff will use it. It is anticipated that existing organizations to a large extent will carry out the planning/analysis by themselves without any assistance from consultants or other experts.

4. Avoid to do the same analysis twice – transparent background information

As a consequence of the WFD, the regional water management level has been strengthened. This may lead to more bureaucracy, at least in the first planning cycle before the new procedures have been well established. It has been highlighted in the Norwegian discussion that partners involved will need to be conscious that the same analysis does not need to be done more than once in order to reduce the bureaucracy and to have a clear understanding of different roles in different stages of the process. Transparent and easy-understandable information about the water status, user conflicts, environmental objectives and assessment of measures is a way to avoid duplication of work. A web-based IT-system is under way to cope with data handling as well as GIS-analysis, information, transparency to facts and reporting.

5. Management plan needs to be flexible in terms of adjustments

The RBMP will be revised every 6^{th} year. This does not mean that the perception of the water status and measures needed, will have to stay unchanged during these 6 years. Mechanisms for updating the plan need to be established. Many abatement measures will take long time before full effects can be expected. It is therefore important that the Program of measures contains both measures already carried out, or that are being planned for, as well as new measures that need to be implemented.

6. Check for instruments to put measures into actions

Formal instruments, like laws and economic arrangements, should be assessed in the RBMP in order to get a realistic view on which measures that can be implemented in one specific planning cycle. If necessary, the plan can make suggestion to develop new instruments for the future. All PRBs emphasize the importance of starting early with the preparation of the river basin management plan because the timing of the WFD is very tight and to work with clearly defined cooperation structures. The importance of getting to know each other within these cooperation structures was also mentioned, both on the national and the international level. Generally, although the importance of cooperation is being acknowledged, several PRBs experience it as a time and resource consuming process. Hence the importance of allocating enough resources for this process was stressed, although these resources are not easily available. Development of integrated management strategies and cost-effective analyses are vital focus points in the process, to ensure as efficient and economically optimal planning as possible. Finally, it often seems easier to reach a consensus in technical discussions between experts than in policy discussions between policymakers, because at that point political and economic interests come into play. Or, in other words, the more political the implementation gets, the slower it goes and the more difficult it becomes to come to decisions.

About Phase II of the Pilot River Basin Activity

Since the adoption of the Water Framework Directive in 2000, a Common Implementation Strategy (CIS) was set up to guide its implementation. In a first phase a set of guidance documents were prepared, which were tested by the Pilot River basins. The outcome of this exercise is reported in the 2005 Pilot River Basin Outcome report. In the second phase – running from 2005-2006 and coinciding with the third CIS work program - the Pilot River Basins have been involved in the different working groups and other activities set up in the CIS, and a wide variety of topics have been subject to pilot exercises. More information can be found on the European Commission's Directorate-General for the Environment Website:

http://ec.europa.eu/environment/water/index.html

The views expressed in this report do not necessarily reflect the views of the European Commission. The contents of this report has not been assessed by the Commission for compliance with the requirements of Directive 2000/60/60, and practices described in the report may therefore not necessarily be compliant with those provisions.

III.3. HYDROMORPHOLOGY

This report was prepared by the Pilot River Basins ***Weser*** *(DE), coordinator of the report,* ***Suldal*** *(N) and* ***Neisse*** *(DE). More information about these river basins can be found in chapter II or at: http://ec.europa.eu/environment/water/water-framework/prbs.htm. The report addresses one specific aspect of the common implementation strategy for the Water Framework Directive (Directive 2000/60/EC), as part of the second phase of a pilot river basin activity.*

III.3.1. Introduction

The physical structures of surface waters have been subjected to changes during the 20th century especially due to navigation, hydropower or flood defence, but also for purposes like agriculture and urban development. Alterations of the river channel's morphology as well as of hydrological processes have a strong impact on the ecological conditions in rivers and streams. Moreover, natural structures of river channels support the self purification process in running waters.

In the analysis of pressures and impacts, according to Art. 5 of the WFD, hydromorphological pressures have been identified as one of the main influences on surface waters leading to the failure of the WFD objectives. In the process of identifying objectives and measures the water use has to be considered.

As in the case of hydromorphological changes the WFD permits member states to designate heavily modified water bodies (HMWB) if certain conditions are met, the PRBs Suldal and Neisse are dealing with this subject. In the case study by Suldal PRB, hydromorphological changes due to hydropower production are paid special attention to in the process of designating HMWB and establishing environmental goals. Neisse PRB describes the coordination process in an international river basin where different methods are applied concerning the designation of HMWB and artificial water bodies (AWB) and the derivation of the good ecological potential (GEP).

For the Weser River Basin an example is given below of how to develop concepts for the improvement of river continuity at both regional and river basin scale.

Relevant requirements of the Water Framework Directive

Hydromorphology (pressure and quality element)

Art. 5, Annex II No. 1.4: Identification of pressures: (…)Estimation and identification of the impact of significant water flow regulation, including water transfer and diversion, on overall flow characteristics and water balances. Identification of significant morphological alterations to water bodies.

Art. 8, Annex V No. 1: Quality elements for the classification of the ecological status in inland waters are (…) hydromorphological elements supporting the biological elements: hydrological regime, morphological conditions and for rivers additionally river continuity

Art. 11 No. 3i: Basic measures(…) consist of(…) measures to ensure that the hydromorphological conditions of the bodies of water are consistent with the achievement of the required ecological status or good ecological potential for bodies of water designated as artificial or heavily modified.

Heavily modified water bodies:

Art. 4 No. 1a, iii: Member States shall protect and enhance all artificial and heavily modified bodies of water, with the aim of achieving good ecological potential (…).

Art. 4 No. 3: Member States may designate a body of surface water as artificial or heavily modified, when: a) the changes to the hydromorphological characteristics of that body which would be necessary for achieving good ecological status would have significant adverse effects on (…) the navigation (…), activities for the purposes of which water is stored, such as drinking water supply, power generation or irrigation; water regulation, flood protection, land drainage (…); b) the beneficial objectives served by the artificial or modified characteristics of the water body cannot, for reasons of technical feasibility or disproportionate costs, reasonably be achieved by other means, which are a significantly better environmental option.

Guidance documents and papers

Hydromorphology is a topic in several guidance documents and papers:

CIS guidance documents:

No. 3: Analysis of pressures and impacts

No. 4: Identification and designation of heavily modified and artificial water bodies

No. 7: Monitoring under the Water Framework Directive

No. 10: Rivers and lakes – Typology, reference conditions and classification systems

Technical Report on WFD and Hydromorphological Pressures: Good practice in managing the ecological impacts of hydropower schemes; flood protection works; and works designed to facilitate navigation under the Water Framework Directive (Nov.2006)

III.3.2. Suldal PRB: Hydromorphological changes due to hydropower

III.3.2.1. Introduction

Hydropower is the most important source to electricity in Norway. About 99,7% of the production come from hydropower. The Suldal River Basin is heavily regulated through several steps, involving power plants, dams, 23 reservoirs and transfer of water cross catchment borders. About 75 % of the catchment is above the timberline at 6-700 m above sea level and can be considered as high-mountain areas. This river basin is representative for many of the regulated river basins on the western coast of Norway.

Hydromorphological Changes

The most important physical alteration is disruption of river continuum and change of downstream dams and stream diversions. The physical alterations results in several hydromorphological changes, especially related to flow conditions, water temperature and sediment transport. Since the flow in the main river has been significantly reduced (about 50 %), the influence and the importance of the inflow from, and the conditions in the local catchment area has been increased.

The mean water flow during the winter are today quite similar to the natural situation, but with less variability. The occurrence of large floods is significantly reduced. Winter temperatures are almost similar to natural conditions, but summer temperatures are lower today compared with before. Regarding sediment transport, bed load calculations indicate that the diversion of almost 50 % of the annual flow, as well as considerable reduction of the floods, probably have reduced the transport capacity of the river (Bogen et al. 1997). This again may lead to accumulation of sediments in the river, resulting in siltation and increasing the level of the riverbed. The extensive accumulation of sand on the river has clogged the interstices between cobbles and boulders and this affects the habitat of many aquatic organisms.

Ecological Impacts

The phytoplankton community is probably near undisturbed conditions in these types of ultraoligotrophic lakes in the Suldal river basin (Lillehammer 1964, Lillehammer and Saltveit 1979 and Rørslett et al 1989). The community of benthic algae shows a normal high species diversity in all groups dominated by species connected to clean water. A considerable amount of acidification sensitive species in the river, show that the river is not strongly affected by acidification. Algae that prefer stone substrate have in general decreased as the moss algae vegetation has increased after the regulation. The diversity of macrophytes is considered to be normal, but quantitatively it has become more moss vegetation in the river. The reasons for this are strongly reduced frequency of large floods, increased winter low flows, less ice cover and by that no events of ice-clogging of the river flow (Rørslett et al. 1989).

The benthic invertebrates show a decline, mainly due to reduction in caddis flies. Main reasons are silting and episodes with acid water through sea salt deposition. Since the Suldal River is a famous salmon river, much attention has been paid to ecological impacts on fish stocks of Atlantic salmon and brown trout. A large variation in catch crops has been seen, and the researchers have not come to a clear conclusion on the impacts of hydromorphological changes. However, it has been concluded that the increase in liverworts in the Suldal River has a negative impact on fish density. Even though the spawning population has been reduced during the nineties, it seems like both the recruitment and the overall smolt production approach the natural carrying capacity of the river system (NVE 2004).

III.3.2.2. Identification and Designation of Water Bodies as Heavily Modified

A national guideline for preliminary identification of HMWB has been developed based on knowledge on ecological impact and corresponding 15 general physical criteria. The PRB project has provided an example of how the Norwegian guidelines are utilised (NVE 2004). Most of the small rivers located downstream of tunnel collection systems have small dams with no or little release of bypass flows. In most cases, the entire river is categorised as heavily modified. Another HMWB criterion that has been adopted throughout the basin is that of lake regulation greater than 3 m. Lakes with more than 5-7 m drawdown are always severely modified ecologically. Between 2 and 5 m is an interval where marginal changes in ecology can be expected and the designation of HMWB may be open for review, but no such examples are found in the Suldal basin. 49 water bodies (of a total of 113 water bodies in the river basin) have been identified as provisional heavily modified. 16 water bodies are lakes/reservoirs and 33 are river stretches. The figures are still to be confirmed by local and regional authorities.

Main screening criteria to identify provisionally as HMWB are as follows:

- ✓ Changes in lake water level:+10 meters;
- ✓ Lakes with an active annual regulation zone: ± 3 meters;
- ✓ Change in the hydraulic load by factor of 5 or more (lakes);
- ✓ No-bypass stream diversion; the 75% criterion;
- ✓ All rivers where minimum environmental flow is required;
- ✓ River no longer covered with ice and winter temperatures always above +1 deg C (as a result of water intakes);
- ✓ Normal annual flow augmented more than 3 times (rivers); and
- ✓ Change in water flow more than 5 % per hour of maximum capacity of the hydropower plant (no peaking).

III.3.2.3. Draft methodology for establishing environmental goals in heavily modified water bodies

A new methodology to establish environmental goals in heavily modified water bodies caused by hydropower regulation has been developed (Skarbøvik et al. 2006). As the basis for the project, the environmental goal called Good Ecological Potential (GEP) was defined as the conditions in a water body 6 years after the implementation of a set of economically acceptable measures that do not significantly affect the water use (i.e. hydropower).

The methodology includes four stages:

1. Categorisation of water body as heavily modified by use of list of criteria (as described in section above);
2. Table of well known mitigation measures, their expected environmental effects and approximate costs; as well as tools to select abatement measures related to habitat preferences. See tables below;
3. A set of economic tools; and
4. Lists of environmental goals for three types of quality parameters in HMWB i.e. fish, invertebrates and aquatic vegetation.

These model tools present a significant modification of the established practice used in the Norwegian management of regulated rivers and lakes. The methodology was tested in five different water bodies in the River Numedalslågen in Norway (originally planned to be tested in the Suldal river basin but changed to Numedalslågen due to administrative and technical reasons). The methodology turned out to be extremely challenging in terms of economic analysis. More than 1500 HMWBs are to be considered in Norway, and it is therefore likely that the cost effectiveness analyses (CEA) will have to be limited to estimates of the direct costs of the potential mitigation measures. The macro-economic cost to society of lost power production also proved difficult to estimate, despite the use of a sophisticated model of the entire Nordic interconnected power system.

The project has also evaluated the effect of introducing an upper acceptances level for the loss of hydropower production, defined as a certain percentage loss of national hydropower production. This approach has been discussed, but the resulting advice is to avoid the use of such an acceptable level.

The use of tables for mitigation measures proved to function satisfactorily when used in the initial screening of suitable measures. It is also believed that the suggested methodology will make it easier to evaluate the effects of the implemented measures.

Illustrative application of methodology in creating a generic list of possible mitigation measures (based on Norwegian experience) from Glover (2006).

The following colour coding has been used to illustrate typical experience gained in Norway on the ecological significance and cost efficiency of each measure in general. Please note that the table is intended only to illustrate a methodology currently being tested in Norway, and does not automatically summarise the final grading of each measure.

Colour 1	Ecological Significance
(green)	Generally positive experience with few negative side-effects
(yellow)	Mixed experience or some negative side effects. Needs site-specific studies
(white)	New or untested measure. Insufficient data to make a judgement. Needs research
(orange)	Some poor experience, or serious negative side-effects. Only used in special circumstances

Colour 2	Preliminary grading according to COST EFFICIENCY in improving ecological status
(dark blue)	Regarded as generally cost-efficient approach to improving status
(medium blue)	Often cost-efficient approach but requires case by case documentation
(white)	New or untested measure, or insufficient data to make a judgement. Needs further analysis
(light blue)	Not generally regarded as cost-efficient in improving status in general, except in special circumstances

Modification	Impact of modification	Description of possible mitigating measure	Likely ecologically beneficial effects of measure	Typical costs / cost efficiency of measure
Heavily Modified Rivers: Dam as structural barrier to the movement of aquatic fauna	Migratory fish unable to access spawning and breeding areas	Install fish pass of design type E3 a-g	Migratory fish can access spawning and breeding grounds	10 – 30 000 Euros per metre of lift required
Heavily Modified Rivers: Water diverted by hydropower intake upstream	River flow reduced and floods nearly eliminated	Environmental flow releases combined with constructing small weirs	Increased wet area improves habitat for some fish and benthos	10 – 100 000 Euros per weir built with in-situ stones
Heavily Modified Rivers: Water diverted by hydropower intake upstream	Severely reduced flow alters habitat conditions for fish, benthos and other species.	Habitat improvement by physical alterations in addition to the above measure (weirs & environmental flows).	Improved habitat designed for specific species, such as trout and salmon.	Successful if good prior knowledge of ecology. Site and type-specific.
Heavily Modified Lakes: Regulated for seasonal variation	Littoral zone becomes barren	Construct a weir to maintain constant water level in small	Good ecological status expected behind the weir	Determined by site-specific conditions. Submerged weir-

in hydro power production		part of reservoir		type not yet built in Norway
Heavily Modified Lakes: Regulated for seasonal variation in hydro power production	Littoral zone is exposed to wave and draw-down erosion.	Coconut matting placed to retard erosion and allow vegetation to root.	Improves vegetation of barren zones, improved habitat, reduces erosion	Determined by site-specific conditions but costly for large reservoirs
Heavily Modified Lakes: Regulated for peak load-following operation	Rapid erosion in littoral zone.	Limitation made on rate of reservoir level draw-down.	Reduces erosion. Uncertain impact on ecological status	Limits operation mode, and reduces flexibility of hydropower in system.

References

Bogen, J., Bønes, T.E. and Benjaminsen, H. 1997. Suldalslågen, sedimentkilder og sedimenttransport. Rapport nr 35. Lakseforsterkningsprosjktet i Suldalslågen (In Norwegian).

Glover, B. 2006. List of measures with corresponding ecological benefits and cost efficiency based on general Norwegian experiences. Draft report. Multiconsult.

Lillehammer, A. 1964. Bunn- og drivfaunane, dens betydning for føde for yngel av laks og ørret I Suldalslågen og Storelva. Hovedsoppgave i zoologi, Universitetet i Oslo, 75 s. (In Norwegian).

Lillehammer, A. and Saltveit, S.J. 1979. Stream regulation in Norway. In Ward, J.V. and Stanford, J.A. (eds.). The Ecology of Regulated Streams. Plenum Press, New york and London, pp. 201-213.

NVE. 2004. Suldal Pilot River Basin, Norway. Provisional Article 5 Report pursuant to the Water Framework Directive. NVE Report 3-2004. 56 p.

Rørslett, B., Johansen, S.W., Blakar, I.A. 1989. Biologiske effekter i Suldalsvassdraget fra Ulla-Førre utbyggingen. Probelmidentifisering og tiltak. NIVA Report O-88050, 172 p. Norwegian Institute for Water Research, Oslo.

Skarbøvik, E., Glover, B., Barton, D.N., Braband, Å., Bækken, T., Halleraker, J.H., Johansen, S.W., Kristiansen, A. and Saltveit, S.J. 2006. Forslag til metodikk for fastsettelse av miljømål for sterkt modifiserte vannforekomster. Med eksempler fra Numedalslågen. NIVA Report 5266-2006, 82 p. (In Norwegian

III.3.3. Neisse PRB: Designation of HMWB/AWB and Derivation of the GEP

III.3.3.1. Foreword

Until now, it was not possible to collect available data to analyse hydro-morphological deficits for the water bodies in the catchment of the Lusatian Neisse, due to a delayed start of the project. Therefore this chapter presents a theoretical approach to develop a trans-national strategy for the definition of a transparent method for the designation of HMWB and AWB.

Thus, the following descriptions do not show any results of the project work but do explain the strategy and methodical approaches for the implementation of the Water Framework Directive (WFD) that are being initially discussed in the PRB-project of the tri-national catchment area of the Lusatian Neisse. That means they are not yet finally inter-coordinated with the project partners nor do they have an authoritative official character within one of the concerned EU-member states or German federal states. Nevertheless these strategies and methods are meant as innovative and practical proceeding proposals for the next steps of the WFD-implementation process in the trans-national PRB Lusatian Neisse.

III.3.3.2. Introduction

The first step of the present project is to compare and analyse the strategies of provisional designation of HMWB and AWB in Poland, Czech Republic and Germany (federal states of Brandenburg and Saxony). For this purpose a catalogue of questions was designed that allows comparing the different national strategies for provisional designation of HMWB and AWB. The provisional designation of HMWB and AWB has been already reported by each member state to the EU in 2004. Based on the results of this completed process of provisional designation of HMWB and AWB an analysis of the specific strategies of the member states enables to find identical and different parts of the particular strategy that can be used to develop an improved trans-national approach for the final designation of water bodies in the catchment of the Lusatian Neisse.

List of questions in the catalogue:

- Number of the HMWB and AWB and their percentages in each national/federal sub-catchment area.
- Length of HMWB and AWB and their percentages in each national/federal sub-catchment area.
- Did you follow the recommendations of the CIS guidance document 2.2 HMWB?
- If yes - Which advice did you follow and what have you done in another way?
- If no – why not?
- Did you identify all those water bodies as HMWB that will not achieve the objectives (good ecological status) because of hydro-morphological reasons?
- Did you do the HMWB-/AWB-identification by expert judgement or automatically with clearly defined rules (which rules)?
- Did you involve stakeholders in the process of the provisional identification of HMWB and AWB? How did you deal with "public participation"?
- Which other criteria did you use for the provisional identification of HMWB? (e.g. criteria for a fundamental change in character or effects of the mitigation measures on the drivers/uses?)
- Did you consider the reversibility of hydro-morphological modifications within the provisional identification process?
- Did you select special uses as reasons for the provisional HMWB-/AWB-identification or did you exclude special uses as reasons?
- Which uses did you consider?
- Did you have any problems distinguishing HMWB from AWB?
- If yes - How did you decide in cases of doubt (pro or contra provisional HMWB/AWB) and for what reason?
- Are lower costs of mitigation measures for AWB and HMWB expected in contrast to natural water bodies (NWB) and if so, did this expectation play a significant role within the provisional identification process?
- How was dealt with national or federal differences within the provisional identification process of trans-national water bodies?
- What do you think: will the national or federal differences within the provisional identification process have relevant consequences on the derivation and definition of the objectives (good ecological potential) for the HMWB/AWB? And if so, which ones? (e.g. changing of threshold values for the assessment of the significance of each pressure and use impairing the water body, or changed rating of the cost efficiency of mitigation measures to achieve the GEP).

The river basin management plans that have to be reported in their final form in 2009 to the EU must include a final designation of all water bodies into the three categories natural (NWB), heavily modified (HMWB), and artificial (AWB). This final designation of HMWB and AWB should be ideally done in a transparent and reproductive way, which is based on clearly defined rules including expert judgement in unclear cases.

Although, the EU Water Framework Directive (WFD) does not demand a common trans-national strategy for the final designation of HMWB and AWB it is one of the project goals to initiate a constructive exchange of experiences, ideas, but also to discuss restrictions and limits concerning the national strategies of the final water body designation for trans-national river basin catchments.

The second step of the project is based on the analysis of the provisional water body designation and will define recommendations for the strategy of final water body designation of trans-national river basins.

III.3.3.3. Provisional Identification and designation of water bodies as heavily modified (HMWB) or artificial (AWB)

During the process of provisional water body identification all those water bodies were identified as provisional HMWB that have been heavily changed in character by human induced hydro-morphological pressures and all man-made water bodies on previous dry grounds are being identified as AWB.

The final designation of HMWB/AWB for the river basin management plan that has to be reported in 2009 is iteratively linked with the ongoing river basin management planning process and has to be adapted when the frame conditions change. Thus, the "final" designation of HMWB/AWB status has to be proved in the course of the planning process of each actualized river basin management plan that will be reported to the EU Commission every 6 years.

According to the CIS guidance document of working group 2.2 HMWB, the most important difference between the provisional identification and the final designation of HMWB/AWB is the consideration of specific uses and biological criteria for the assessment of the ecological status of each water body which only have to be considered within the designation process but not within the former provisional identification.

Based on the results of the biological monitoring programme it has to be proved that the hydro-morphological pressures really cause accordant heavily degradations of the biological quality components. Thereafter the effects of the necessary mitigation measures to improve the ecological status of the water body on the sustainable uses have to be proved whether significant negative socio-economic effects caused by the mitigation measures are expected. Only if these socio-economic and biological preconditions are given, a water body can be designated as heavily modified and only those mitigation measures that will not significantly impair the specific and necessary use of the water body can be performed.

In different research projects (i.e. BMBF-projects MAKEF and Werra 2004 and 2005) no significant relationship between the qualities of hydro-morphological structures and biological components (fishes, macroinvertebrates, macrophytes, and phytobenthos including diatoms) could be found, if only the local conditions of the sampling sites were considered. These correlations became much better (i.e. for the macroinvertebrates), when in addition to the local conditions of the water body also the conditions of the whole upper stream reaches and the colonisation potential of organisms immigrating from tributaries were considered.

Therefore it can be assumed, that in many cases the results of the biological monitoring programme will not approve the results of the estimation of the achievement of the objectives (good ecological status) for water bodies and of the provisional identification of HMWB, due to the restricted appraisal of habitat survey data only for the rated water body which does not account for the abiotic and biotic influences of the upstream conditions and tributaries.

The provisional identification of HMWB has been done in many different ways with different criteria in the member states of the European Union.

In Germany these first steps were mostly based on the results of surveyed and mapped streams and rivers according to two different methods: the detailed "on-site survey" and the overview method using aerial photographs. Depending on the availability of the data the different federal states used the data of these two methods. In addition to these differences each federal state used its own set of rated assessment parameters of the particular method of river habitat survey and also rated the relevance of the heavily modified parts for the provisional identification in relation to the total length of the whole water body by preset specific parameters. Therefore different minimum parts of a water body were defined to justify the provisional identification of a water body as HMWB (e.g. if more than 50 % of the total length of a water body was rated as heavily modified). Also the percentages of automatic or expert judgments in the process of HMWB-identification were quite diverse in Germany and in some cases also use-specific criteria were considered already for the provisional HMWB-identification.

Principally the provisional identification and the designation of HMWB/AWB can be done individually for each water body as well as for groups of homogeneous cases with comparable frame conditions. The decision between these alternatives or for a combination of both has to consider the direct consequences for the definition of the environmental objectives and the assessment of the ecological potential that will be assigned to the specific water body or group of water bodies. Very important for the comparability of the environmental objectives and the assessment of the ecological potential are also the spatial scale, the level of detail and the selection of the criteria for the HMWB-designation and MEP-/GEP-definition.

The goal of a case group designation should be the selection of uniform combinations of mitigation measures that are appropriate to achieve the maximum and good ecological potential for all water bodies within a specific case group. Therefore the use-specific restrictions and the potentials for the improvement of the ecological status of the water bodies as well as the attainable goals in the development of typological different water bodies (e.g. gravel upland versus sandy lowland stream) have to be considered.

The definition of grouping criteria should be performed with caution. A coarse separation of groups, can likely result in the risk to fail the preset environmental objectives in individual cases. On the other hand too much differentiation between the groups could be in contrast to the biological differentiability or could result in too heterogeneous assessment results for principally comparable combinations of the water body types and uses.

III.3.3.4. Definition of the "good ecological potential" (GEP)

The maximum ecological potential (MEP) that describes the reference conditions of the artificial and heavily modified water bodies must be defined for each HMWB/AWB (EG WFD, appendix II, chapter 1.3; CIS GD of WG 2.2 chapter 2.1). The definition of the MEP takes into consideration the impacts of the HMWB-relevant uses respectively the uses for which the artificial water bodies have been created on the particular stream biocenosis. HMWB- and AWB-relevant uses are according to the WFD all those which are sustainable for human development and would be significantly impaired by the mitigation measures necessary for the achievement of the good ecological status (GES). These can be more uses than only one (i.e. navigation, urbanisation, hydropower, flood protection, agriculture).

The WFD demands not to achieve the MEP by mitigation measures for the particular HMWB/AWB, but the good ecological potential (GEP) which presets the environmental objectives for the measures (EG WFD, 4(1) (iii)). The GEP defines an ecological status of a freshwater biocenosis that slightly deviates from the MEP. The achievement of the GEP does not require the realisation of all conceivable mitigation measures (as it would be the case in achieving the MEP).

The CIS WG ECOSTAT has actually developed a new alternative method for the definition of the GEP. (Technical report "Good practice in managing the ecological impacts of hydropower schemes; flood protection works; and works designed to facilitate navigation under the Water Framework Directive" (November 2006) ANNEX II: „Alternative Methodology for defining Good Ecological Potential (GEP) for Heavily Modified Water Bodies (HMWB) and Artificial Water Bodies (AWB)"; the annex consists of the version 4 of the GEP-Paper, which has been endorsed by ECOSTAT with reservations of COM, FR and EEB).

The most relevant innovation of the new GEP-derivation method in comparison to the procedure of the CIS-GD of WG 2.2 is the fact that the new procedure for the first time allows a direct derivation of the GEP via mitigation measures and not via a biologically gradation of the MEP.

The new alternative procedure is now proposed as an equal method which principally leads to the same results but should be more secure and pragmatic because of its direct way of derivation without an intermediate step of constructed and assessed biological conditions. The following figure shows a schematic diagram of both procedures:

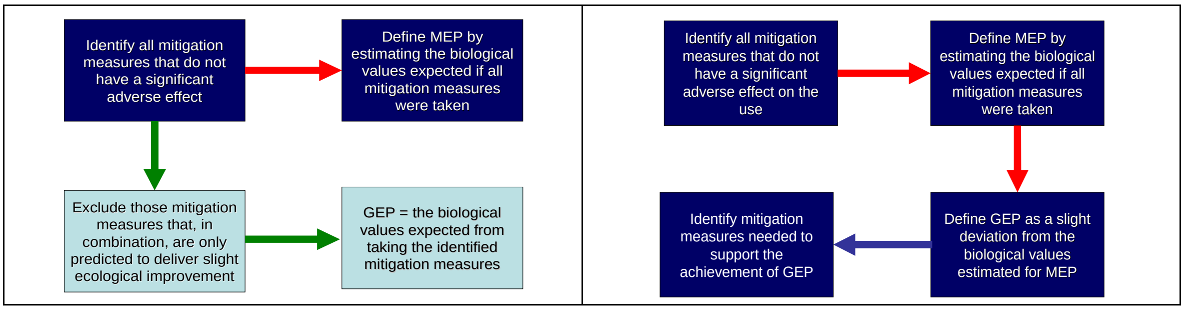


Figure 8. Comparison of the ECOSTAT alternative procedure (left) and the procedure according to CIS GD of WG 2.2 (right).

The most relevant advantage of the alternative procedure is the fact that the consequences of the preset environmental objectives (GEP) for the selection of the necessary mitigation measures are predictable, while the former procedure could lead to a selection of combinations of measures that are not really practicable.

Both procedure proposals still do not consider costs and cost efficiency of the mitigation measures in common. This discount of a cost analysis can result in the definition of GEP-conditions that can only be achieved by very expensive mitigation measures or measure combinations which in fact can not be realised due to limited financial budgets. The consequence could be the excessive use of the less stringent environmental objectives for many freshwaters.

The above presented alternative procedure for the derivation of the GEP is being preferred within the frame of the PRB project due to the open questions concerning the assessment methods for the biological quality components to define the GEP for HMWB and AWB and with regards to the remaining short time schedule. A goal of the PRB-Neisse project is to improve the actual procedure of GEP-definition by incorporating the aspects of costs and cost efficiency of the mitigation measures for the derivation of the GEP.

The precondition for including the cost aspects of measures into the process of GEP-definition is a standardisation of the rating and designation of the measures respective the criteria and scales. Therefore it is advisable not to consider individual cases but case groups with uniform conditions. It has to be assured that comparable frame conditions result in the same environmental objectives independent of possible differences in the particular financial budgets.

In the frame of the PRB-project Lusatian Neisse the following results are aimed at:

- ✓ Synopsis of the different national or federal procedures for the provisional identification, designation and derivation of the environmental objectives (GEP) of HMWB in the river basin of the Lusatian Neisse
- ✓ Procedure proposals for the HMWB/AWB-designation process and for the derivation of the GEP
- ✓ Exemplary realizations of the developed proposal at selected water bodies in the catchment area of the Lusatian Neisse

References

CIS WG 2.2 2002: Guidance Document for the Identification and designation of heavily modified and artificial water bodies.

ECOSTAT 2006: Good practice in managing the ecological impacts of hydropower schemes; flood protection works; and works designed to facilitate navigation under the Water Framework Directive (November 2006)

Federal Ministry of Education and Research (BMBF) 07/2001 - 08/2004: Research-Project – Developing methods to designate heavily modified water bodies and defining the good ecological potential according to the WFD (MAKEF)

Federal Ministry of Education and Research (BMBF) 05/2002 - 05/2005: Research-Project – Strategies for a water management plan in the Werra basin (Germany) according to the WFD – Part ecology

III.3.4. Weser PRB: The Enhancement of River Continuity - River Basin and Regional Concepts

III.3.4.1. Introduction

According to the first risk assessment of the Art. 5 report 24 % of water bodies in the Weser River Basin are possibly at risk to fail the objectives of the WFD due to significant hydromorphological alterations, for another 35 % of water bodies it is not clear if the objectives will be achieved. The longitudinal continuity is one of the hydromorphological elements for the classification of the ecological status. With numerous obstructions in smaller rivers and streams and several weirs in the river Weser itself, continuity is one of the main issues implementing the WFD in the Weser River Basin.

Long distance migratory fish species represent approx. 20 % of all fresh water fish species in the Weser River Basin. To develop sustainable populations of migrating (diadromous and potamodromous) fish species in the catchment (tab.1), passages in rivers as well as spawning grounds and nursery habitats in streams and small rivers have to be improved.

The River Basin Commission Weser has developed an approach to deal with this task at different levels – at a river basin scale focusing on the supra-regional migration routes and at regional or local scale concentrating on continuity as well as on the spawning and nursery habitats in small streams and rivers.

III.3.4.2. The approach at river basin scale

The enhancement of river continuity demands a wide ranging concept. Concrete environmental objectives regarding migratory species have to be identified, and priorities of measures and areas will be derived considering specific ecological demands of diadromous and potamodromous species as well as the cost effectiveness analysis.

Organisation and working structure

The council of the River Basin Commission Weser consisting of the Federal States' authorities in the River Basin agrees upon river basin-wide objectives and necessary steps. The secretary of the River Basin Commission supported by an advisory expert group of fish ecologists and members of the water management of the Federal States' authorities prepares the steps, informs and advises the council. The concept will be concretized within the time schedule of the implementation process regarding environmental objectives and water management issues before the end of 2007.

Steps of a river basin concept:

Identification and assessment of main migration routes and suitable spawning and nursery habitats (Phase 1 and 2). In a first step the main migration routes for selected native migratory fish species (tab. 1) were identified. These migration routes are the Weser and its main tributaries in their lower stretches as far as they are important for the access of habitats. The routes were selected based on historical occurrence of the fish species and in compliance with the biological reference conditions. The migration routes are of supra-regional relevance for the connection of populations and differ for the targeted species within the river basin. Figure 9 presents the maximum setting of migration routes of approximately 1.900 km length in the Weser River Basin for all target species.

In a second step, tributaries which provide suitable and accessible spawning and nursery habitats and which contribute to an ecological network of habitats of diadromous species and populations of potamodromous species will be identified.

Subsequently, obstructions in the main corridor and the identified tributaries will be assessed with respect to their continuity considering the specific demands of both target species and local fish fauna. For this purpose the data on weirs and other transverse obstructions will be compiled in a river basin wide database. The assessment will be mainly based on those technical criteria which have an ecological impact.

Derivation of priority areas and measures (Phase 3). The results of phase 1 and 2 will be the basis for the identification of relevant areas and possible measures with respect to fish ecological demands concerning continuous passage of corridors and connectivity of habitats. The associated costs of potential measures will be estimated and, hence, the technical feasibility assessed. Looking at ecological benefits and cost effectiveness priority measures will be derived. Results and experiences from regional projects but also already available data are taken into account and are being looked at from a river basin wide perspective.

Derivation of objectives and measures (Phase 4 and 5). Fish ecological priorities and the cost effectiveness analysis will provide the basis for a priority list of measures. The objectives are identified in an iterative process analogue to the set priorites at a river basin wide scale. These objectives will have an effect on local and regional objectives and, hence, there is a top-down and bottom-up process of information and negotiation necessary. Fig. 10 shows the process of deriving objectives and measures.

Table 1. Migratory fish species of the Weser River Basin, preliminary list of target species.

fish species		ecological criteria		
species	**scientific name**	**historical occurrence in RB Weser**	**migration type 2)**	**mobility**
river lamprey	*Lampetra fluviatilis*	yes	anadromous	long distance
sea lamprey	*Petromyzon marinus*	yes	anadromous	long distance
sturgeon	*Acipenser sturio*	yes	anadromous	long distance
flounder	*Platichthys flesus*	yes	catadromous	long distance
allis shad	*Alosa alosa*	yes	anadromous	long distance
twaite shad	*Alosa fallax*	**1)**	anadromous	medium distance
salmon	*Salmo salar*	yes	anadromous	long distance
sea trout	*Salmo trutta f. trutta*	yes	anadromous	long distance
houting	*Coregonus oxyrinchus*	yes	anadromous	long distance
smelt (migrating subspecies)	*Osmerus eperlanus*	yes	anadromous	medium distance
barbel	*Barbus barbus*	yes	potamodromous	medium distance
ide	*Leuciscus idus*	yes	potamodromous	medium distance
vimba	*Vimba vimba*	yes	potamodromous	medium distance
burbot	*Lota lota*	yes	potamodromous	long distance
threespine stickleback (migrating subspecies)	*Gasterosteus aculeatus*	yes	anadromous	medium distance
eel	*Anguilla anguilla*	yes	catadromous	long distance

1) = unverified data

2) **diadromous (anadromous and catadromous)** species migrate between fresh water and sea
anadromous species spawn in fresh water and migrate to sea
catadromous species spawn in the sea and migrate to fresh water
potamodromous species migrate within fresh water

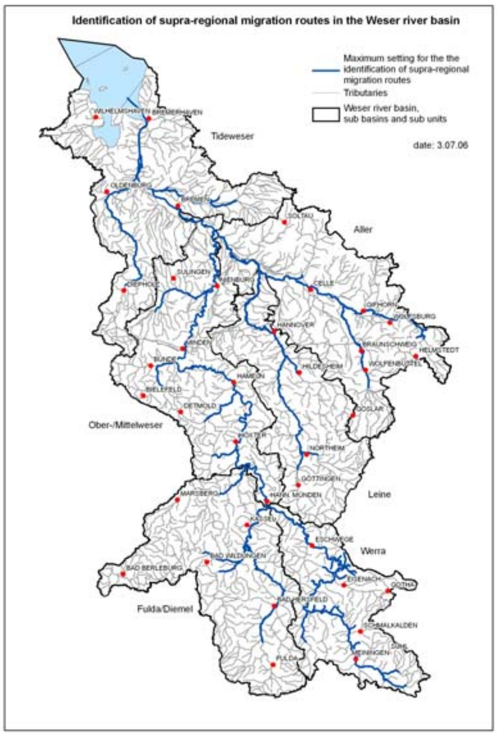


Figure 9. Maximum setting of migration routes of approximately 1.900 km length in the Weser River Basin for all target species.

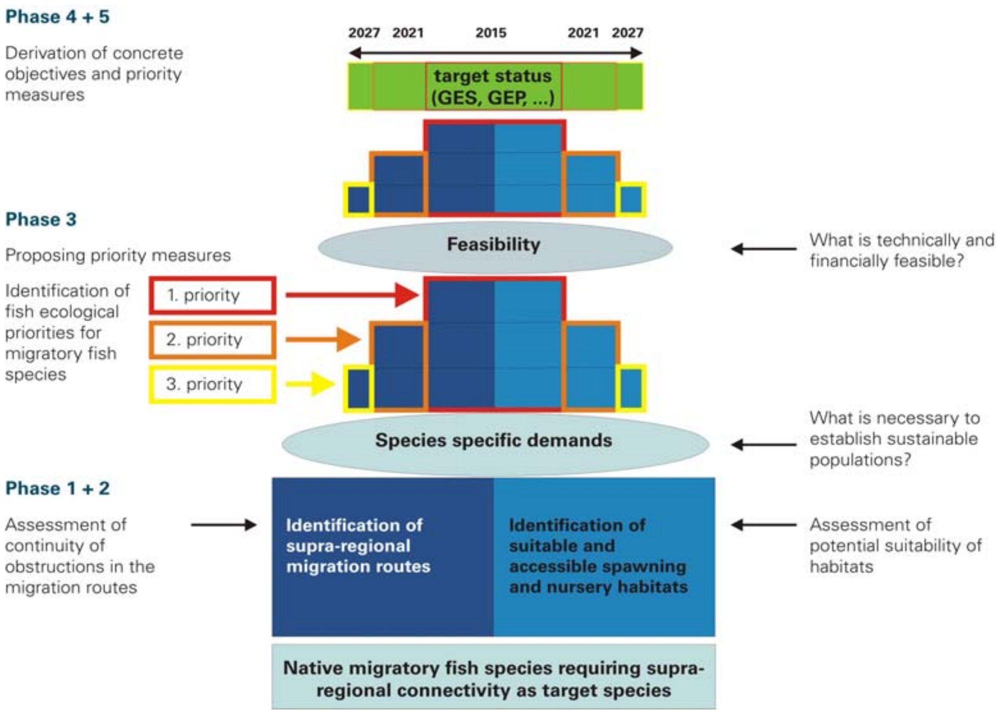


Figure 10. Derivation of objectives and priority measures.

III.3.4.3. The approach at regional to local scale

In several local and regional pilot projects within the Weser River Basin strategies and measures to improve river continuity and habitats are being developed at present (fig. 11). E.g. in the project "Enhancement and connection of aquatic habitats in the Werra" measures such as removal of weirs and barriers and construction of fish passes but also the improvement of habitat morphology have been identified and already partly implemented. The project area is situated in the south east of the Weser river basin in the Federal State of Thuringia and covers the river Werra and also its main tributaries. Priority areas have been identified and the measures are implemented in an order that establishes continuity starting from river confluence leading upstream.

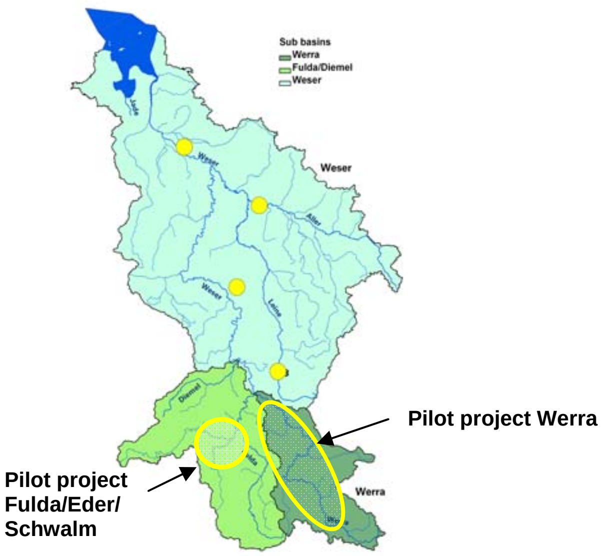


Figure 11. Pilot projects dealing with river continuity in the Weser River Basin.

With the pilot project “Deriving priorities of measures to enhance the aquatic river continuity in the catchment of the coordination area Fulda/Diemel” the Federal State of Hesse is focussing on the issue of river continuity and hydromorphology in the south western part of the Weser catchment. Different measures and their combinations were determined. The methodology for the identification of priorities and cost-effectiveness has been tested in detail for selected water bodies and later applied to other water bodies with comparable pressures in order to test the transferability of methods and results. This pilot project serves as a regional example and is closely linked with an overall river basin wide concept of improving river continuity.

Project organisation

The project is carried out by the Federal State of Hesse, administrated by its regional authority in Kassel and commissioned to the Center for Environmental System Research of the University of Kassel and an engineering consultancy. A working group representing hydropower, agriculture, fishery, nature conservation, water resources management, navigation authorities, spatial planning and local authorities agrees and decides upon the steps within the project. Public participation is conducted with a regional advisory council which consists of stakeholder representative institutions such as the chamber of agriculture and the hydropower association.

Characterization of project area

The 52 water bodies of the project area have a total length of 1.133 km and form a surface river basin of 3.005 km^2. The water bodies can be assigned to the upper and lower trout region (epi- and metarhithral), the grayling region (hyporhithral) as well as the barbel region (epipotamal). In total, there are 290 transvers
basin district analysis “interrupt the river continu

Fig. 3: pilot projects for river continuity

Table 2. Characteristics of the project area.

Number of water bodies	-	52
River basin size	km²	3.005
River length	km	1.133
River types (according to German typology)	-	5; 5.1; 9; 9.1*
Number of water bodies with morphologic impairments on >70% of the river length	-	11
Number of transverse structures with probably significant effect on the river continuity (GESIS-Information system on river habitat survey)	-	290
Land use		
Agriculture	%	51
Forestry	%	39
Settlement, traffic, other uses	%	10
* Type 5: Small coarse substrate dominated siliceous highland rivers Type 5.1: Small fine substrate dominated siliceous highland rivers Type 9: Mid-sized fine to coarse substrate dominated siliceous highland rivers Type 9.1: Mid-sized fine to coarse substrate dominated calcareous highland rivers		

The hydromorphological status is diverse among rivers and streams. In particular, approximately 2/3 of the total river length in the project area has been evaluated as being “distinctly” to “completely changed” in their structural quality (classes 4 – 7 of the German Stream Habitat Survey).

In order to specify the pressures and impact assessment, 12 out of 52 water bodies were selected for detailed analysis. Selection criteria were restricted continuity, variety of hydromorphological states, ecological type but the absence of other significant pressures, especially wastewater and diffuse pollution or dangerous substances.

Steps in the regional pilot project - Method of prioritization of measures

The general steps of the method for the prioritization of measures are shown in fig 12. In step 1, specific biotic and abiotic parameters were considered in order to describe the present status of rivers and streams with respect to their habitat potentials and ecological deficits. In step 2 this information was linked in order to identify the number of barriers and necessary restoration measures to achieve the "good status". Step 3 comprises a series of calculations for the assessment of required investments for the implementation of measures. The budgets were calculated in detail based on classified costs, e. g. for weirs depending on type, use and river width. The costs were calculated for each barrier and further aggregated for individual streams and water bodies.

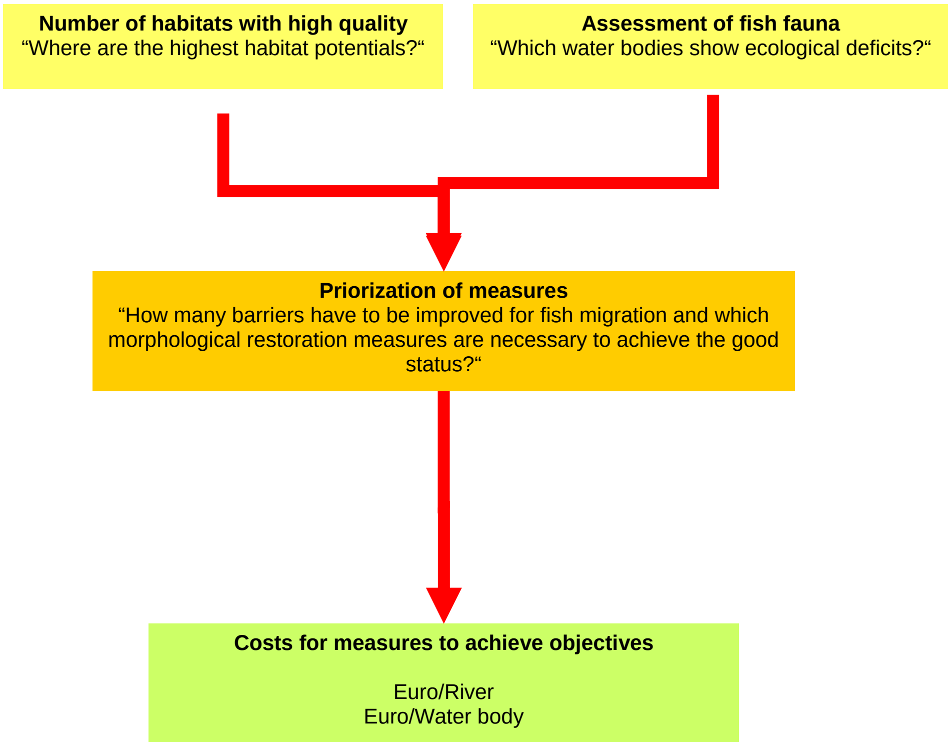


Figure 12. Principal steps for the prioritization of measures to achieve continuity and ecological sufficient morphological quality of streams.

Habitats with sufficient hydromorphological quality

The derivation of the environmental objectives based on "partial objectives" related to abiotic parameters is a fundamental precondition for the identification of measures and the assessment of ecological effectiveness since measures usually have direct effects on supporting components rather than on biological components. Furthermore, costs for measures can be quantified according to their effects on the abiotic environment. Therefore, we separated the analysis of abiotic conditions with regard to restoration potential and the ecological assessment based on ecological indicators (in this case the fish fauna). In a subsequent step we have quantified relations between biotic and abiotic parameters as far as possible in order to develop information about ecological effectiveness of measures. These were defined as biotic responses to changed abiotic conditions caused by the implementation of measures.

The emphasis of the pilot project is "to re-establish the aquatic river continuity" by consideration of hydromorphological features, for which suitable restoration measures have to be developed. For this purpose, the parameters were defined in such a way that by sticking to the set of objectives the water bodies of the project area may reach the "good status". By comparing the selected parameters with the actual conditions a deficit analysis is accomplished which has been the basis for the following determination of measures. For the water bodies of the project area hydromorphological components were identified which were of special significance for the fish fauna as relevant biological indicator responding to restricted continuity and hydromorphological degradation.

Based on recent studies with tests of monitoring methodologies according to the EU-WFD and on the basis of expert judgements the structural parameters represented in Tab. 3 were selected. For the assessment of the habitat quality, particularly in the rhithral zones (headwaters) of river networks, the structural parameters depth variance, substrate diversity and special bed structures were proved to be significant. For these parameters there is a stronger correlation between the composition and abundance of the fish fauna when compared with the complete morphological assessment with a set of 28 single parameters. Despite a certain heterogeneity of the requirements for fish habitats it was possible to identify subsets of hydromorphological parameters which were further separated for the functionalities "spawning grounds" and "nursery habitats".

Table 3. Parameter combinations for the detection of habitats with biologically sufficient morphological quality for small (< 5m width, parameter combination 1), medium (5m-10m width, parameter combination 2) and big sized rivers (>10m width, parameter combination 3).

Parameter combination	Structure parameter	Specification
1	Water width	< 5m
	Longitudinal banks	≥ one
	Traverse banks	≥ one
	Depth variance	very large, large, moderate
	Substrate type	sand, gravel, crushed stone, stones, blocks
	Substrate diversity	very large, large, moderate
2	Water width	5m-10m
	Longitudinal banks or traverse banks	≥ one
	Depth variance or width variations	very large, large, moderate
	Substrate type	sand, gravel, crushed stone, stones, blocks
	Substrate diversity or special bottom structures	very large, large, moderate ≥ two
3	Water width	> 10m
	Longitudinal banks or special structures of the river course	Structure or bank beginning to establish ≥ one
	Backwater	no
	Diversity of currents	very large, large, moderate
	width variations	very large, large, moderate

The parameter "bottom structure" of the morphological survey is a crucial parameter for the assessment of the habitat quality for the aquatic fauna. For large rivers and by methodological reasons, this parameter was not detected in a homogenous way during the stream habitat survey in Hesse. Therefore, despite of the ecological significance it had to be excluded from further analysis.

A GIS-based analysis was performed in order to identify the sections of rivers with parameter combinations for habitats with "sufficient quality" for the fish fauna and the location of barriers. The analysis revealed a significant variety in the distribution of habitat quality and barriers (fig. 13).

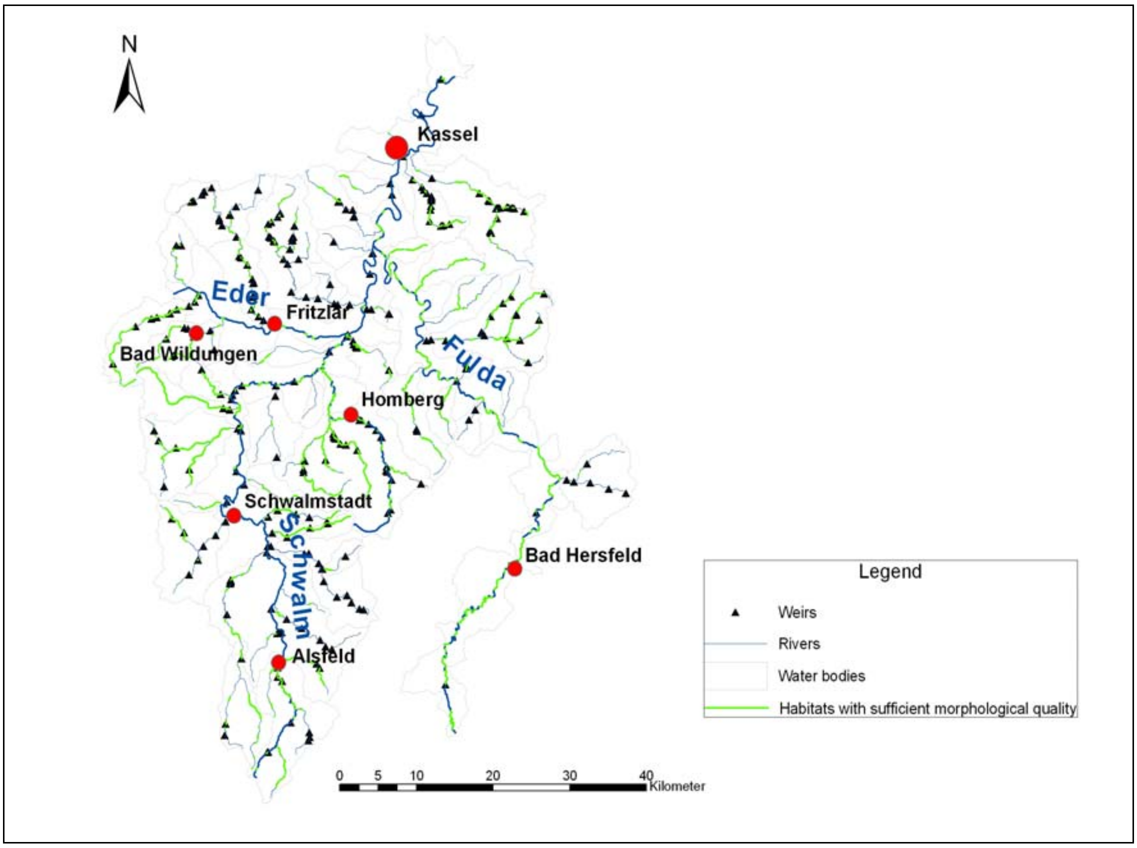


Figure 13. Habitats with sufficient morphological quality (green lines) in the catchment of Fulda, Eder, Schwalm and the location of weirs and barriers (black triangles).

Assessment of fish fauna

Based on reference lists for the fish fauna of each river which describe the "very good ecological status" based on historical records and recent fauna, target species for achieving the environmental objective "river continuity" were determined. Furthermore, the ecological status with regard to the fish fauna was assessed. Therefore, an initial focus has been made to consider the connectivity of the river network within and between different ecological zones. Furthermore, for the assessment of the river continuity the LAWA (German Working Group of the Federal States on water issues) working group "surface water bodies" advices not only to consider the local environmental objectives, but also the river basin network with its type-specific natural habitats. For this purpose, the target species of the fish fauna vary from the reference fish coenosis and focus on those species that migrate medium and long distances. The respective list has been developed by the "expert group fish fauna" of the River Basin Commission Weser and will be used for the determination of long-distance migration corridors (see chapter 2.3.2).

Prioritization of measures

Cost-efficient combinations of measures within the respective water bodies were identified by analysing the quantity and location of spawning and nursery habitats from the stream habitat survey and their location related to barriers. Furthermore it is assumed, that 25 – 60 % of a river have to be in a condition with sufficient morphological quality in order to achieve a good ecological status. All this information will be summarized for individual streams and rivers and aggregate a series of information which is necessary for prioritization, esp. number of barriers, habitats separated by barriers and habitat quality compared to ecological target. A principal example is given in fig. 14.

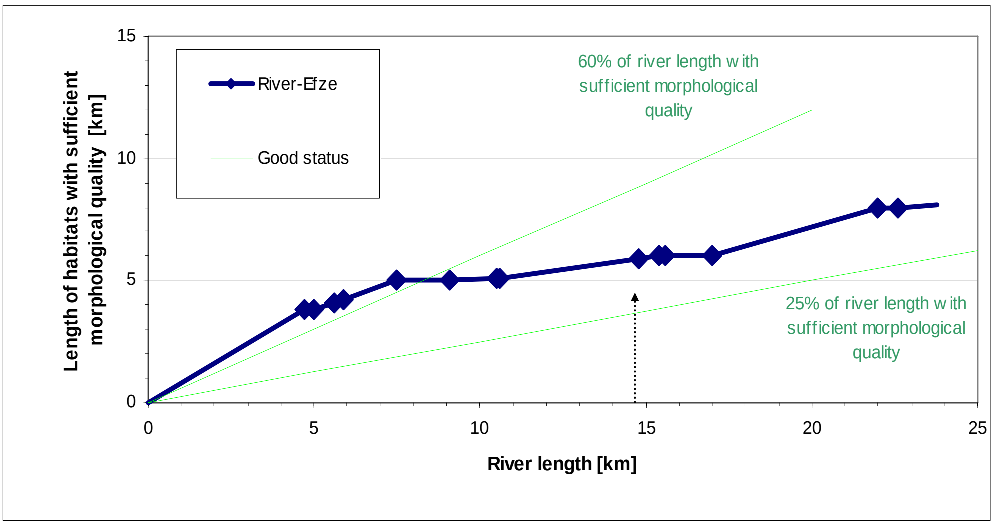


Figure 14: Longitudinal profile of habitats with sufficient morphological quality in the upper river Efze (blue line), location of barriers (dots). Green lines indicate conditions with 25 and 60 percent of river length with sufficient morphological quality. This condition is assumed to be necessary for achieving the "good status".

Costs of measures to achieve objectives

In a subsequent step the costs to achieve a complete continuity for each river or stream were calculated on an individual basis using classified costs. An example of costs for different types and barriers separated by river width is shown on fig.15. It is obvious that classifications may be necessary in order to limit the variability of costs for given measures.

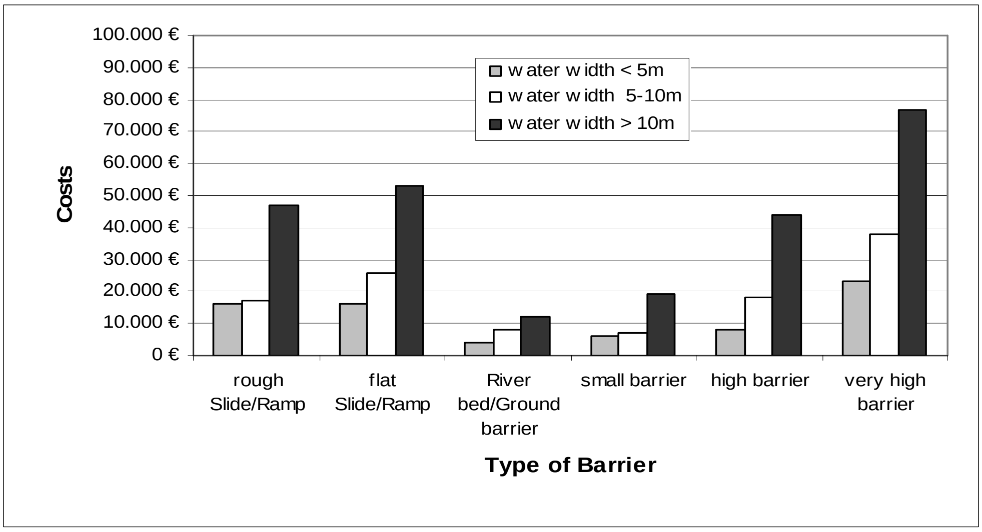


Figure 15. Costs for measures for the achievement of longitudinal connectivity for different types of barriers and separated by river size.

The information about costs and length of connected habitats with sufficient morphological quality may be plotted for each river and allow the derivation of all relevant information with regard to cost effectiveness (fig. 16). These will be further aggregated for ecological zones, river networks, water bodies, water body groups and even river catchments.

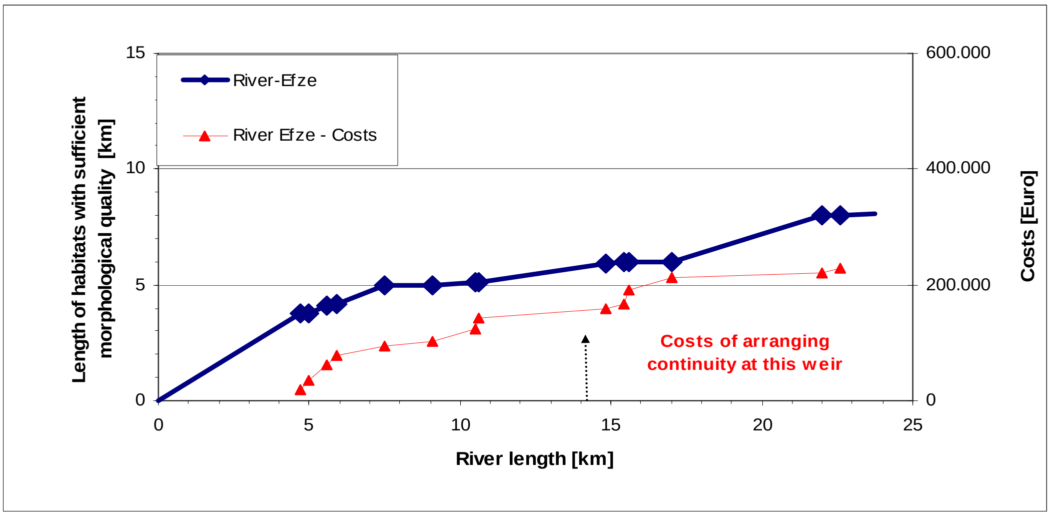


Figure 16. Longitudinal profile of habitats with sufficient morphological quality for the fish fauna (blue line) and cumulative costs for the achievement of river continuity by ecological improvement of weirs and barriers (red line).

III.3.5. Conclusions and recommendations

Sufficient morphology quality and river continuity have been identified as one of the major topics for implementing the WFD in the river basins. In the Suldal River Basin hydromorphological pressures are caused by hydropower and, therefore, mitigation measures are mainly targeted at this sector. Rivers and lakes that are subjected to the hydromorphological changes have been provisionally designated as HMWB when certain criteria were met, almost 45 % of all water bodies in the river basin. A draft methodology provides an approach to establish environmental goals for the HMWB defining the Good Ecological Potential as the condition in a water body 6 years after the implementation of a set of measures not entailing disproportionate costs that do not significantly affect the water use. Considering mitigation measures in the process of defining the Maximum Ecological Potential and deriving the Good Ecological Potential is also the approach intended within the international Neisse PRB project. Both Suldal and Neisse take the cost of measures and their cost efficiency into account to allow for the definition of a GEP that is actually feasible excluding measures not entailing disproportionate costs. Furthermore, in both approaches the designation process refers to case groups rather than individual water bodies.

In the Weser River Basin strategies for mitigating impacts from barriers and degraded hydromorphology by integration of ecological demands of migratory fish species and the actual status of river continuity at different levels are developed. At the river basin level measures focus on the improvement of important migration routes whereas at regional or local level, as well as connectivity of habitats, the enhancement of habitat structure and quality is of major importance. Moreover, the regional projects provide examples involving stakeholders and the public. In order to find cost effective solutions, the concepts will support the selection of priority areas and measures aiming at the largest achievable uninterrupted network of ecologically “good” river stretches. The criteria for the derivation of priorities at regional scale that have been developed in the pilot project “Fulda/Eder/Schwalm” are: the costs to create continuity, the length of habitats with sufficient morphological quality that will be accessible when establishing continuity, and efficiency (length of the connected habitats in relation to costs).

The presented approaches of the PRBs are aimed at establishing environmental objectives. In the PRBs Suldal and Neisse objectives for HMWB are looked at, in the Weser PRB objectives with respect to continuity and migratory fish species are considered. As a result feasible and cost effective measures that will improve the status in the river basins will be identified.

About Phase II of the Pilot River Basin Activity

Since the adoption of the Water Framework Directive in 2000, a Common Implementation Strategy (CIS) was set up to guide its implementation. In a first phase a set of guidance documents were prepared, which were tested by the Pilot River basins. The outcome of this exercise is reported in the 2005 Pilot River Basin Outcome report. In the second phase – running from 2005-2006 and coinciding with the third CIS work programme - the Pilot River Basins have been involved in the different working groups and other activities set up in the CIS, and a wide variety of topics have been subject to pilot exercises. More information can be found on the European Commission's Directorate-General for the Environment Website

http://ec.europa.eu/environment/water/index.html

The views expressed in this report do not necessarily reflect the views of the European Commission. The contents of this report has not been assessed by the Commission for compliance with the requirements of Directive 2000/60/60, and practices described in the report may therefore not necessarily be compliant with those provisions.

III.4. INTERCALIBRATION / CLASSIFICATION

*This report was prepared by the Pilot River Basins **Jiu** (RO) coordinator of the report and **Odense** (DK). More information about these river basins can be found in chapter II or at: http://ec.europa.eu/environment/water/water-framework/prbs.htm. The report addresses (one) specific aspect(s) of the common implementation strategy for the Water Framework Directive (Directive 2000/60/EC), as part of the second phase of a pilot basin river activity.*

III.4.1. Introduction

The intercalibration exercise aims to agreement between all Member States on the good status class boundaries, thus exceeding the level of the (pilot) river basin. However, the ECOSTAT WG invited the Pilot River Basins to contribute to the intercalibration exercise with data, where possible and where needed.

The Jiu PRB being located in Romania has contributed with official and supplementary sites and data to the intercalibration exercise through the Eastern Continental Geographic Intercalibration Group (EC GIG). The intercalibration exercise performed within the Eastern Continental GIG is co-ordinated by the International Commission for the Protection of the Danube River (ICPDR) Permanent Secretariat and includes – according to its ecoregions - the following countries: Austria, Bulgaria, Czech Republic, Hungary, Slovak Republic and Romania.

It is necessary to develop methods and tools for assessment and classification of designated water bodies in order to achieve the objectives of the Water Framework Directive (WFD). An assessment tool, the HELCOM Eutrophication Assessment Tool - HEAT, has been developed for meeting the demands of the WFD. The results of a national Danish intercalibration exercise testing the HEAT tool on Odense PRB and 13 other marine areas are presented.

Relevant requirements of the Water Framework Directive:

(Annex V, 1.2)
Normative definitions of ecological status classifications.

(Annex V, 1.4.1, iii):
Each Member State shall divide the ecological quality ratio scale for their monitoring system for each surface water category into five classes ranging from high to bad ecological status, as defined in Section 1.2, by assigning a numerical value to each of the boundaries between the classes. The value for the boundary between the classes of high and good status, and the value for the boundary between good and moderate status shall be established through the intercalibration exercise.

III.4.2. Odense PRB: Classification exercise

III.4.2.1. Background

Establishment of reference conditions (RefCon) for the various ecological quality elements is important as a starting point or anchor in the assessment/classification process, because the designated water bodies are assessed through the socalled Ecological Quality Ratio (EQR), defined as the ratio between the current, observed status and RefCon (Annex 5, part 1.4.1 of WFD); EQR ranges between 1 (equal to RefCon) and 0 (the worst possible ecological status).

The EQR scale is subsequently separated into different quality classes - High, Good, Moderate, Poor, and Bad – describing the ecological status. The management target is the boundary between Good and Moderate ecological status, and as WFD contain only normative definitions for these two status classes (Annex 5, part 1.2.4), it is a challenge to actually set the boundary between them – 'the acceptable deviation' from RefCon – as it implies a translation of these definitions into percentages or values.

For coastal waters four quality elements are considered in WFD - phytoplankton, submerged aquatic vegetation, invertebrate benthic fauna, and physical-chemical elements. Within each quality element a suite of indicators - e.g. for the latter physical-chemical group it could be nutrients, transparency, temperature, salinity, and others - are the 'units' that deliver the basic EQR's. The EQR's for the indicators combine to give the EQR for the quality element, and these again combine to provide the ecological status using the 'one out-all out' principle (Annex 5, part 1.4.2), by which the water body is classified according to the lowest quality class.

All of the above-mentioned features/challenges are contained/addressed in HEAT. In addition, sensitivity tests addressing to what extent both errors in the setting of RefCon as well as application of weighting between indicators affect the final EQR outcome, are presented. It might seem appropriate to introduce weighting between indicators, a feature not addressed in the WFD, to account for cases where RefCon values for the indicators within a quality class, for various reasons, are not equally reliable or differ in importance. Finally, the tentative assessments for the 15 study sites carried out using the HEAT tool is compared with assessments using the OSPAR COMPP and HELCOM EUTRO procedure.

III.4.2.2. Study sites and data sources

The test of HEAT was carried out along a gradient thought to represent sites close to pristine conditions (e.g. open Skagerrak) to sites where eutrophication effects are evident (e.g. Odense Fjord). Of the 15 study sites, 3 are open waters, 7 are coastal waters and the remaining 5 are estuaries (fjords); Odense Fjord contributes 2 sites, the inner and outer part, to the latter group. The 15 study sites represent sizes ranging from 4 (Randers Fjord, inner part) to 4136 km^2 (Skagerrak, open parts), mean depths ranging from 0.8 (Odense Fjord, inner part) to 331 m (Skagerrak, open parts) and mean salinities ranging from 2.5 (Randers Fjord, inner part) to 32.5-32.9 PSU (Hirtshals and Skagerrak, open parts).

The reference conditions for the different quality elements have been established using a variety of sources, i.e. historical data, reference sites, modelling (numerical or statistical) and expert judgement or almost any combination of these. It is important to note that the RefCon values are not established for a quality element *per se* but for each indicator, implying that each quality element can be described by one to several indicators. It should also be noted that all RefCon values here are based on site-specific information from a vast variety of data sources as opposed to the type-specific approach in the WFD. Thus, 89 site-specific RefCon indicator values have been established for the 15 sites with an average number of 6 indicators per area (range: 3-11). Numerical modelling and historical data dominated providing 53 and 29% of the RefCon values, respectively, statistical modelling and expert judgment providing the remaining 10 and 4%, respectively.

A total of 30 indicators have been used in HEAT, with 3, 6, 10 and 11 indicators within the 4 quality elements, phytoplankton, submerged aquatic vegetation (SAV), invertebrate benthic fauna (IBF) and the physico-chemical group (PC), respectively. The many indicators used in the two latter groups are due to no less than 6 different uses of fauna biomass for IBF and multiple use of nutrient concentrations for PC, e.g. nitrogen is used both as a sum of its dissolved inorganic forms and as total nitrogen and both as seasonal and annual means. The most commonly used indicators in the testing of HEAT were chlorophyll *a* concentrations being used 15 times, biomass of IBF (10, sum of all indicators involving biomass), eelgrass depth limit (9), primary production (7), and winter concentrations of dissolved inorganic nitrogen and phosphorus (both 6).

The current status for the indicators, to which the RefCon value is held up against to provide the EQR, is based on monitoring data from the comprehensive Danish National Marine Monitoring and Assessment Programme and regional monitoring data from Danish counties. Data are from the period 2000-2004 and transformed so as to fit RefCon values.

III.4.2.3. Assessment principles

The approach to assess the eutrophication status of a water body is simple. If the eutrophication status (EQR) is within the range defined by the acceptable deviation from the reference condition, i.e. the boundary between Good and Moderate status, the ecological status is acceptable and *vice versa*. This corresponds to the water body being considered an "eutrophication non-problem area" and "eutrophication problem area", respectively, *sensu* OSPAR COMPP and HELCOM EUTRO.

The EQR of a quality element is calculated as the average of the applied indicator-EQR's (if more than one) using different weights prior to averaging. In line with the WFD, the decisive

EQR in this exercise is the quality element with the lowest EQR using the "one out, all out" principle.

A critical feature in WFD is the definition of the acceptable deviation from the reference condition, i.e. the boundary between Good and Moderate status. Setting that breakpoint is so far still an unresolved issue in the implementation of the directive; to that end, 5 different distribution patterns of the quality classes have been tested in HEAT. The five tested distribution patterns along the EQR scale are one each for the 85% and 75% boundaries and three for the 50% boundary (table 4). While the 3 different distribution patterns for the 50% acceptable deviation from RefCon will not affect the class score of a QE if used uniformly for all indicators, application of different distributions/patterns between indicators and/or the use of partial randomness in weights and RefCon may introduce a different outcome. All percentages are arbitrary. The 50% deviation is in line with OSPAR COMPP.

Table 4. Scenarios and quality classes used in HEAT. The classes are expressed as EQR values. Note that the boundary between acceptable and unacceptable deviation form RefCon, e.g. the Good/Moderate boundary is indicated with a bold line.

Scenario	Ecological Quality Ratio				
	High	Good	Moderate	Poor	Bad
85% Good	[1.00–0.95[	[0.95–0.85[	[0.85–0.65[	[0.65–0.375[	[0.375–0.00]
75% Good	[1.00–0.90[	[0.90–0.75[	[0.75–0.53[	[0.53–0.25[	[0.25–0.00]
50% Good#1	[1.00–0.75[	[0.75–0.50[	[0.50–0.30[	[0.30–0.05[	[0.05–0.00]
50% Good#2	[1.00–0.60[	[0.60–0.50[	[0.50–0.42[	[0.42–0.05[	[0.05–0.00]
50% Good#3	[1.00–0.85[	[0.85–0.50[	[0.50–0.15[	[0.15–0.05[	[0.05–0.00]

Reflecting the likely fact that determination of RefCon is less precise than determination of the current status, a sensitivity analysis was carried out by randomly varying RefCon values ±25% around themselves (using >100 Monte Carlo runs). Recognizing the relatively arbitrary nature of the weighting, a similar procedure was applied varying the weights ±25% around initial weights. Initial weights for the indicators were scaled from 1 (limited importance) to 4 (large importance); typically, historical data were given the largest weights, expert judgment the lowest weights, larger weights were given to "primary indicators" (e.g. N and P) than to combinations (e.g. N:P ratio), and low weights were given to "indirect" estimates (e.g. area affected by anoxia based on macrofaunal distribution), etc.

III.4.2.4. Assessment results

The assessment of eutrophication status in the 15 marine areas using the HEAT tool is shown in table 5. Inner and outer parts of Odense Fjord are number 14 and 15, respectively. The open waters scored highest, as expected, because they in general are closer to pristine conditions than the coastal waters and estuaries. The ecological status was thus acceptable (High or Good) in Area 1 and 2, but only at the higher allowed deviation from RefCon ('75% Good' and '50% Good', respectively) whereas it was unacceptable (Moderate or worser) in Area 3 irrespective of the boundary and distribution pattern of the quality class. All 7 coastal areas were, not surprisingly, in an unacceptable state irrespective of the boundary and distribution pattern of the quality class, except one area (7) which attained acceptable ecological status in the '50% Good' scenarios only. The same applied for the estuaries where the assessment resulted in all 5 sites being in an unacceptable ecological state. For the two PRB areas in Odense Fjord (14 and 15), the ecological state was concordantly assessed as not acceptable (i.e. Poor or Bad, Moderate in one of the '50% Good' scenarios). This is completely in line with an earlier analysis published in the provisional Article 5 report from Odense PRB.[5]

A comparison between classification with and without the use of weighting (simple average of the indicator-EQR's in the latter case) resulted in only 2 changes out of 43 classifications at the quality element level; both cases were unimportant changes from Poor to Bad in the '85%

[5] *Fyn County (2003): Odense Pilot River Basin. Provisional Article 5 report pursuant to the Water Framework Directive. Fyns Amt, 132 p.*

Table 5. Tentative assessment of eutrophication status in areas 1 to 15. Scenario denote acceptable deviation of current status from RefCon (= boundary between good and moderate) and different distribution patterns of quality classes along the EQR. The overall assessment is equal to the quality element (QE) with the lowest EQR using the 'one out-all out' principle.

Scenario	QE	Area														
		---- Open ----		-------------- Coastal -----------------								------ Estuaries ----------				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
85% Good	Plank.	M	P	P	B	P	P	P	B	M	M	P	M	P	P	P
	SAV	-	P	-	-	P	P	M	P	P	P	B	B	-	P	B
	IBF	-	-	-	-	-	B	-	-	-	-	P	-	B	-	-
	PC	G	P	B	M	P	P	P	P	B	B	P	P	-	B	B
	Overall	M	P	B	B	P	B	P	B	B	B	B	B	B	B	B
75% Good	Plank.	G	M	P	P	M	P	M	P	G	G	P	M	P	P	M
	SAV	-	M	-	-	M	P	M	P	M	M	B	B	-	P	B
	IBF	-	-	-	-	-	B	-	-	-	-	P	-	B	-	-
	PC	H	M	B	M	P	P	M	P	B	P	P	P	-	P	P
	Overall	G	M	B	P	P	B	M	P	B	P	B	B	B	P	B
50% Good#1	Plank.	H	G	M	P	G	M	G	P	H	H	M	G	M	M	G
	SAV	-	G	-	-	G	M	H	M	G	M	P	P	-	M	P
	IBF	-	-	-	-	-	P	-	-	-	-	M	-	P	-	-
	PC	-	G	P	G	M	M	G	M	P	P	M	M	-	P	P
	Overall	H	G	P	P	M	P	G	P	P	P	P	P	P	P	P
50% Good#2	Plank.	H	H	P	P	H	M	G	P	H	H	M	H	M	P	H
	SAV	H	H	-	-	G	M	H	M	H	H	P	P	-	P	P
	IBF	-	-	-	-	-	P	-	-	-	-	M	-	P	-	-
	PC	-	H	P	H	M	M	G	P	P	P	M	P	-	P	P
	Overall	H	H	P	P	M	P	G	P	P	P	P	P	P	P	P
50% Good#3	Plank.	G	G	M	M	G	M	G	M	G	G	M	G	M	M	G
	SAV	-	G	-	-	G	M	G	M	G	G	M	M	-	M	M
	IBF	-	-	-	-	-	M	-	-	-	-	M	-	M	-	-
	PC	H	G	M	G	M	M	G	M	M	M	M	M	-	M	M
	Overall	G	G	M	M	M	M	G	M	M	M	M	M	M	M	M

Good' scenario that had no impact on the overall classification. Similarly, the sensitivity test showed little effect of randomly varying the weightings of the indicators in terms of the EQR outcome. In contrast, the testing of uncertainty in the setting of RefCon by randomly varying RefCon values ±25% had a larger effect, i.e. SD ranged between 5 and 15% of the EQR average for the tested site. Further, adding indicators reduced the uncertainty, i.e. from 15 to 5% going from 1 to 5 indicators.

III.4.2.5. This is what we learnt

Tools to assess eutrophication have so far strongly focussed on temporal trend assessment rather than on ecological status. Only OSPAR and HELCOM have robust tools for the latter purpose, but they do not, in various ways, comply with the WFD. The HEAT tool developed to assess the eutrophication status, i.e. the ecological status *sensu* WFD, meet the requirements of the WFD, because it uses reference conditions; the ecological quality ratio; the 'one out-all out' principle; 5 quality classes (H-G-M-P-B) including an acceptable deviation from RefCon defining the boundary between good and moderate ecological status; and finally it uses all four quality elements (phytoplankton, submerged aquatic vegetation, invertebrate benthic fauna and the physical-chemical group) each described by a number (3-11) of indicators.

III.4.2.6. Reference conditions

Being the anchor in assessment of the eutrophication status, this study emphasizes the necessity of having reliable information on reference conditions. If reliable EQR values are not generated the outcome of the classification is biased. Scientists should carry out the technical task of establishing RefCon independently of political interests in terms of setting of boundaries and prioritization of measures. Despite the task being difficult due to limited availability of reference sites and historical data, establishment of reference data has improved during the last few years of intercalibration activities connected to WFD implementation. However, there is still an urgent need to establish type or site specific information on RefCon.

Despite historical data being highly rated in the generation of RefCon, they should be treated with caution because of possible differences in methodology compared to current methods. The possible significance of such differences should be determined. If significant, methods to correct for the differences should be considered, often involving a necessary touch of expert judgment.

An example of such mismatching methods are eelgrass depths; where recent data in Denmark represent the maximum depth, historical data represent the distribution of dense eelgrass meadows. In order to account for this discrepancy, current status is calculated as 90% of the maximal distribution thus representing the current depth limit of the dense eelgrass meadows. Another potential problem is the natural variability influencing the actual value of the historical data. This might be overcome by using long time series, if available, where natural variability is levelled out, or by applying ecological modelling where RefCon is generated from average climatic conditions and reference nutrient loads.

The RefCon values in this study were primarily based on historical data and numerical modelling with expert judgement accounting for only 4% of the determinations. The reduced use of expert judgment is an improvement in relation to previous similar exercises, e.g. it was 36% in a recent Baltic survey, but it should be reduced further and replaced by historical data and modelling.

III.4.2.7. Indicators and indicator weighting

The sensitivity test concerning the higher uncertainty connected to determination of RefCon relative to current status showed importantly, that the standard variation of a quality class EQR determination decreased with increasing number of indicators. It is recommended to include as many indicators as possible in order to make the classification more robust and lessen the risk of misclassification.

Only 2 out of 43 classifications of EQR at the quality class level changed when indicator weighting was applied (and neither changed the assessment of ecological status), and the sensitivity test showed that the effect of variability in the weighting was very small. A reasonable suggestion could then be not to care about weighting at all. We propose to apply weighting in some form simply because all available information should be used; weighting principles should be used to distinguish 'strong' indicators from less reliable or less 'important' indicators rather than skipping them. The weighting applied here is admittedly crude and essentially based on expert judgment, and future work should introduce statistical methods in the weighting procedures.

III.4.2.8. Acceptable deviation from reference conditions

A crucial step in the assessment process is the definition of what constitutes an acceptable deviation. Like scientists should be responsible for the setting of RefCon (see above), translation of the normative definitions in WFD into numeric class boundaries should also be drawn up by a scientific approach. Conclusions regarding the acceptable deviation are still missing, however. (But it should be noted that the final recommendation based on results of the WFD-forced intercalibration between member states is very close to being published). HEAT has worked with different scenarios, in which the important boundary between Good and Moderate ecological status has been set at 15, 25 and 50% deviation from RefCon. A 50% deviation is likely to be beyond the definition of a moderate deviation *sensu* the WFD; especially for indicators where RefCon is the maximum value and the maximum deviation per definition cannot be larger than 100% (e.g. Secchi depth), the allowable deviation from RefCon should clearly be less than 50%. In general, the justification for using a 50% deviation from Refcon, as used in OSPAR COMPP, is not adequately documented. This implies that only percentages below 50% should be considered.

III.4.2.9. Comparison of assessments

Comparison of assessments carried out by OSPAR COMPP,[6] HELCOM EUTRO[7] and HEAT is shown in table 6.

Table 6. Comparison of OSPAR COMPP, HELCOM EUTRO (see footnotes 3 and 4) and the tentative assessments of eutrophication status in areas 1 to 15 (the latter also presented as 'Overall' in tab. 2).The colours used in relation to OSPAR COMP and HELCOM EUTRO denote "eutrophication problem area" (red) and "eutrophication non-problem area" (green).

Assessment / Scenario	Area														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
OSPAR COMP															
HELCOM EUTRO	n.i.	n.i.													
85% Good	M	P	B	B	P	B	P	B	B	B	B	B	B	B	B
75% Good	G	M	B	P	P	B	M	P	B	P	B	B	B	P	B
50% Good#1	H	G	P	P	M	P	G	P	P	P	P	P	P	P	P
50% Good#2	H	H	P	P	M	P	G	P	P	P	P	P	P	P	P
50% Good#3	G	G	M	M	M	M	G	M	M	M	M	M	M	M	M

The outcome of the classification by HEAT is identical to the earlier assessments of the Danish coastal waters,[3,4] and the outcome is identical irrespective of the method in almost all cases. Thus, all estuaries (areas 11-15), all coastal areas (areas 4-11) except one as well as the open-water area 3 (the Arcona Basin) are classified as 'problem areas', i.e. in an unacceptable ecological state. In the other two open-water areas, generally considered to be in a better ecological state than the coastal areas and estuaries, there is agreement that area 1 is a 'non-problem area' except in the most stringent HEAT-scenario, whereas in area 2, and in area 7, only the 50% deviation will result in an overall classification as Good or High. An acceptable deviation of 50% hardly agrees with the moderate deviation from RefCon (see section 3.3 above), and when the more stringent scenarios are applied there is agreement with the earlier assessments that these sites are 'problem areas'; this is also consistent with the general understanding of their status.

III.4.2.10. Perspectives

The HEAT tool seems to be pragmatic and transparent besides being consistent with requirements of the WFD. Accordingly, HELCOM has initiated work in order to test HEAT on a convention-wide scale. This work, which will be finalized in December 2006, is expected to result in a few changes in the way HEAT calculates/estimates ecological status. The adjustments are all consistent with the requirement of the WFD and consequently the upcoming HELCOM integrated thematic assessment of eutrophication in the Baltic Sea will be based on a tool that matches the WFD. Further, HELCOM is about to initiate work related to development of tools for assessment of conservation status sensu the Habitats Directive. The

[6] *Ærtebjerg, G., J.H. Andersen & O.S. Hansen (Eds.) (2003b): Nutrients and Eutrophication in Danish Marine Waters. A Challenge for Science and Management. National Environmental Research Institute. 126 pp.*

[7] *Andersen, J.H. (Ed.), J. Aigars, U. Claussen, B. Håkansson, H. Karup, M. Laamanen, E. Łysiak-Pastuszak, G. Martin & G. Nausch (2005): Development of tools for assessment of eutrophication in the Baltic Sea. DHI Technical Report. 68 pp.*

idea is to modify HEAT into a tool which is based on (i) area, (ii) structure, function and stability, (iii) species, (iv) hydromorphological features, and (v) supporting features. If succeeding, the result will be a tool for both assessment of 'ecological status' and 'conservation status'. Such a tool, if generally accepted, would facilitate all types of assessments of ecosystem health and might in the future turn out be useful in relation the to recently proposed Marine Strategy Directive[8]. Development of assessment tools, converging assessment procedures of the WFD with other related directives, is all things being equal a way to strengthen the joint implementation of all directives in question and to enhance the value of the efforts put into this work.

III.4.3. Jiu PRB: Intercalibration exercise

III.4.3.1. Introduction

The WFD requires that the boundaries between high and good and between good and moderate status to be established through an intercalibration exercise (Annex V, 1.4.1, iii). The purpose of this exercise is to ensure comparability of the Ecological Quality Ratio (EQR) scales and to obtain common understanding of ecological status classification of the surface waters all over EU.

An intercalibration network has been established representing a common understanding of the normative definitions of surface water status (defined in WFD in Annex V, section 1.2) in relation to reference conditions.

The Commission is responsible for facilitating the intercalibration exercise through ensuring information exchange between Member States, preparing a draft register of intercalibration sites (intercalibration network), and publishing the results of the intercalibration exercise. The process is being facilitated by the DG - Joint Research Centre (JRC) and coordinated by the WFD CIS Working Group 2A on Ecological Status (ECOSTAT). The ECOSTAT Working Group has established 14 Geographic Intercalibration Groups of Member States (GIGs) on the basis of ecoregions and the similarity of types.

The Jiu PRB being located in Romania has contributed with official and supplementary sites and data to the intercalibration exercise through the Eastern Continental Geographic Intercalibration Group (EC GIG). The intercalibration exercise performed within the Eastern Continental GIG is co-ordinated by the International Commission for the Protection of the Danube River (ICPDR) Permanent Secretariat and includes – according to its ecoregions - the following countries: Austria, Bulgaria, Czech Republic, Hungary, Slovak Republic and Romania.

III.4.3.2. Study sites and data collection

The Eastern Continental common intercalibration river types are characterised by the following descriptors:

- ✓ ecoregion according to ILLIES (1978);
- ✓ catchment area (of stretch) in size classes following System A;
- ✓ altitude – for each of the classes a specific altitude range is given;
- ✓ geology (siliceous, calcareous or mixed);
- ✓ substrate.

The Jiu Pilot River Basin has 2 intercalibration sites in the Eastern Continental Rivers GIG for the following common IC type: R-E1 (Carpathians: small to medium, mid-altitude), R-E2 (Plains: medium-sized, lowland).

Ranges of environmental characteristics of intercalibration sites

IC type code	altitude [m a.s.l.]	catchment size [km^2]	river width [m]	geology	substrate

[8] *Anon (2005). Establishing a Framework for Community Action in the field of Marine Environment Policy. Proposal for a Directive of the European Parliament and of the Council. COM (2005) 505. (The Marine Strategy Directive).*

R-E1	**500 - 800**	**10 - 1000**	**1.5 - 30**	**siliceous**	**gravel and boulder**
R-E2	**< 200**	**100 - 1000**	**3 - 100**	**mixed**	**sand and silt**

Name of IC site (river in the Jiu PRB)	Common IC type	Ecoregion	Ecological status
Ustream Campa (Jiu de Est)	**R-E1**	**10**	**H/G**
Upstream Motatei (Balasan)	**R-E2**	**12**	**H/G**

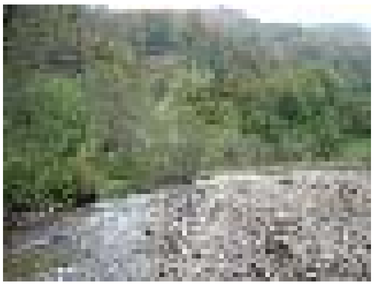


Figure 17. Jiu de Est upstream Cimpa (left) and Balasan upstream Motatei (right).

In 2005, there were organized 2 campaigns for collection of new samples from these 2 sites and also from other 6 supplementary sites (reference conditions sites and best available sites). These supplementary sites are the following: Paraul Galben - upstream Baia de Fier, Susita - upstream Vaidei, Drincea 1 - upstream Podu Grosului, Jilt - upstream Turceni, Danube - Pristol, Danube - Gruia, Danube – Oltenita and belong to R-E1, R-E2, R-E4 and R-E6 common types. These samples collected from supplementary sites were necessary to make the statistical analyses of the data in order to obtain the values for EQR (ecological quality ratio). For each site a complete characterization has been completed, concerning:

the hydrological parameters: flow (daily flow/yearly medium flow);

physico-chemical and chemical parameters: temperature [°C], pH, conductivity [mS/cm], alkalinity [mmol/l], dissolved oxygen [mg/l], oxygen saturation [%], COD-Mn [mg/l], COD-Cr [mg/l], BOD_5 [mg/l], $P\text{-}PO_4^-$ [mg/l], Ptotal [mg/l], $N\text{-}NO_3^-$ [mg/l], $N\text{-}NH_4^-$ [mg/l];

biological elements/indicators: macroinvertebrates – taxa list (species level), abundance (ind/m^2) and saprobic index.

The abiotic and biotic data were reported to the National Administration "Apele Romane" and after that to the coordinator of the Eastern Continental Rivers Group – ICPDR.

Figure18. Paraul Galben upstream Baia de Fier (left) and Susita upstream Vaidei (right).

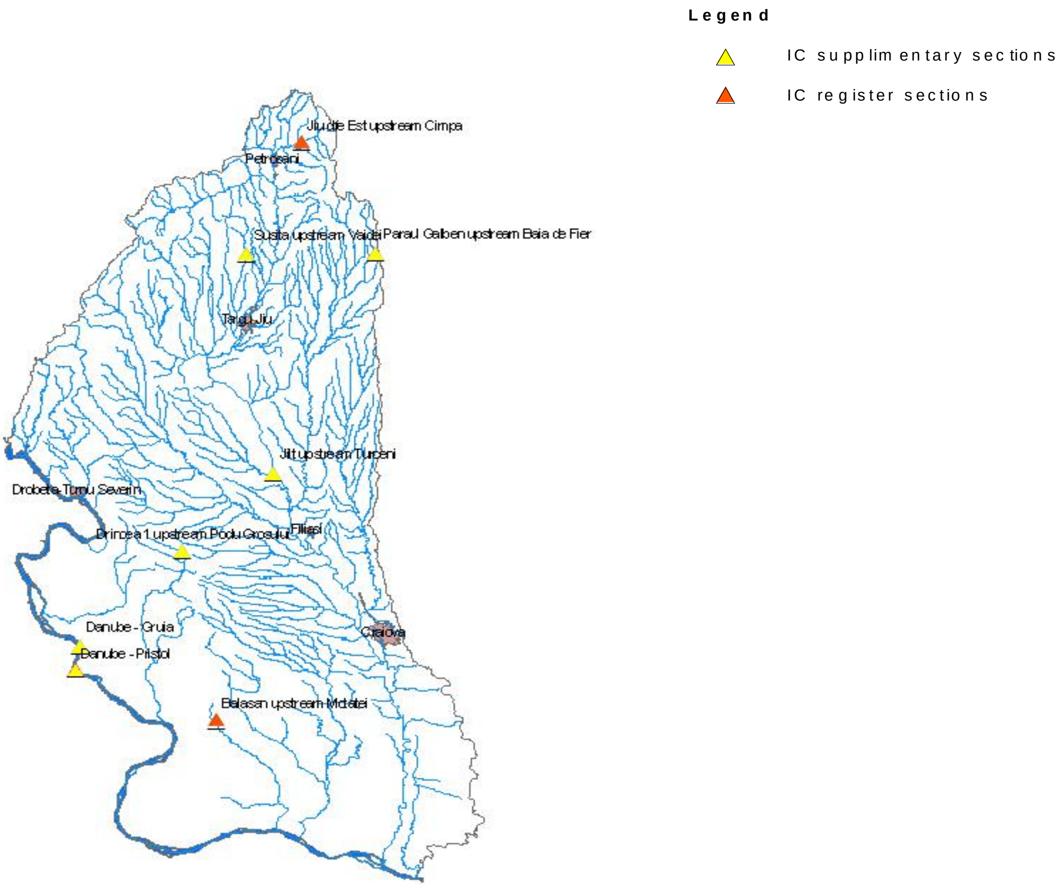
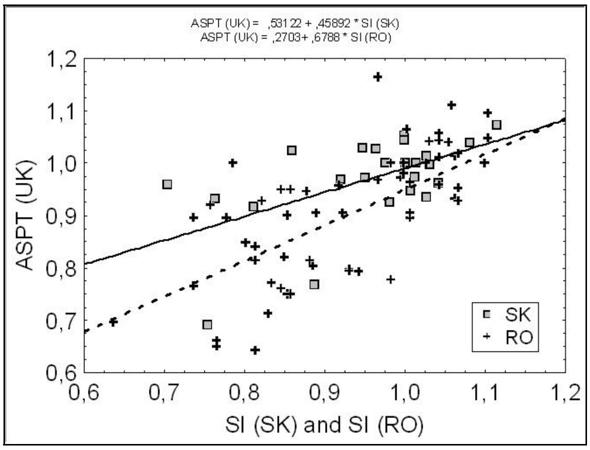


Figure 19. Intercalibration sites from PRB Jiu.

III.4.3.3. Assessment principles

At the level of EC GIG, the intercalibration exercise has been exclusively performed using benthic macroinvertebrates and the ICPDR is responsible for compiling and hosting the database. In order to assess the biological quality of watercourses in the Jiu PRB, the saprobic index (according to PANTLE and BUCK method) has been determined and classified in a five-fold scheme. The biological quality element (BQE) sampled and assessed was the macroinvertebrates. For the benthic macroinvertebrates, the national biomonitoring data (including for registered intercalibration sites) cover the entire quality gradient (according to national index) for all common stream types which have been analyzed.



	SI (SK)	SI (RO)
# samples	24	93
r	0,57	0,68
Ref Val	1,31	1,52
ASPT (UK)		
H/G	**0,90** *+/-0,04*	**0,87** *+/-0,01*
G/M	**0,82** *+/-0,05*	**0,79** *+/-0,02*

Figure 20. Intercalibration results (macroinvertebrates).

Within the intercalibration exercise the definition of reference conditions has a major importance for the comparison of national quality assessment methods. Therefore, the EC GIG agreed to follow an alternative approach to resolve these issues by defining IC type specific, harmonized quality criteria. In general, the GIG set common high-good respective good-moderate quality class boundaries for the national biological assessment methods using existing data assembled within the EC GIG intercalibration exercise.

The results have been filled in the template for the reference sites in order to establish the ecological class boundaries at the beginning of 2006.

Reference sites were chosen by the GIG countries using the criteria defined in the REFCOND guidance. Following the work done in the Central-Baltic GIG, a list of more detailed criteria and type-specific concentrations of key chemical parameters were agreed by the EC GIG. Countries were performed the screening of the selected reference sites against agreed chemical, hydromorphological and catchment landuse threshold limits. Countries were also asked to complete a check list to indicate which reference criteria - defined in the GIG - were used for the screening exercise. The template has been sent to the coordinator of the Eastern Continental Rivers – GIG.

For mountainous rivers types, reference conditions for benthic invertebrates were available already after the first collection of biological data and abiotic information. No reference information related to large rivers (Danube – R-E6) and lowland rivers (R-E2) is available. For the data assessment of these types (R-E2, R-E6), there wasn't possible to find enough reference sites and for this reason the best available sites approach is used.

It was clear that methods used by the GIG countries differ in compliance and state of development in relation to WFD normative definitions. The GIG therefore agreed on the construction of a common metric (Intercalibration Common Metric index (ICMi) which is intrinsically compliant with the normative definitions so that the countries' data can be converted to ICMi.

The ICMi-EC developed for the Eastern Continental GIG consists of four common metrics combined to a common multimetric index by using the average of normalized metric values. The following table specifies the common metrics, WFD indicative parameters addressed and pressures indicated (based on pressure analysis of EC GIG dataset):

Common Metric	WFD indicative parameter	Indicated Pressure
Average Score Per Taxon (ASPT)	**Sensitive Taxa**	**Organic Pollution, General Degradation**
Austrian Structure Index (family level)	**Sensitive Taxa**	**Structural and General Degradation**
Total Number of Families	**Taxonomic composition, diversity**	**General Degradation**
[%] EPT Abundance	**Taxonomic composition, abundance, major taxonomic groups**	**Organic Pollution, Structural and General Degradation**

Class boundaries were set in terms of ICMi values derived from data-subsets complying with the criteria for a certain quality status. These criteria cover various aspects of human impacts on rivers including general and structural degradation and organic pollution.

In the Eastern Continenal GIG, harmonised class boundaries were defined within a GIG-wide agreed framework. The GIG decided that national class boundaries will be adjusted according to the results of the intercalibration analysis. Therefore, national class boundaries were not compared between countries but against the boundary values obtained in the intercalibration analysis. This year the intercalibration exercise has been done just for the countries which have national assessment method compliant with WFD regarding the common intercalibration types R-E1, R-E2 and R-E4. Results of further country/type combinations, based on non-WFD compliant methods, are expected in 2007-2008.

III.4.3.4. Next activities

Regarding the continuation of the intercalibration exercise within the Jiu PRB through the EC GIG, the following issues will be addressed:

- ✓ completing the data through the continuation of the monitoring process in the intercalibration and reference conditions/best available sites;
- ✓ using other BQEs (phytoplankton, macrophytes and fish fauna) for the continuation of the IC exercise;
- ✓ using only WFD compliant sampling/assessment methods.

III.4.4. Conclusions and recommendations

III.4.4.1. Jiu PRB

The following conclusions can be drawn:

- the biological analyses need a common assessment and a unique methodology (harmonization);
- the chemical methods must be improved – especially for the priority hazardous substances;
- final intercalibration can only be done for all EC GIG countries when WFD-compliant methods are available, but preliminary intercalibration is currently performed with non WFD compliant methods.

Currently, further supplementary data for reference sites/best available sites are collected in order to improve the IC exercise. Information on best available sites for some common type is collected to enable the intercalibration of large rivers. For lowland streams and large rivers the reference sites are almost impossible to find, the main cause being the existence of anthropogenic pressures.

III.4.4.2. Odense PRB

The assessment and classification tool HEAT is simple, pragmatic and transparent besides being consistent with requirements of the WFD; the latter because it uses reference conditions (Ref Con); the ecological quality ratio, the 'one out-all out' principle; all quality classes including an acceptable deviation from Ref Con (defining the boundary between good and moderate ecological status); and all 4 quality elements each described by a number of indicators.

The HEAT tool generates one overall EQR value for each water body based on EQR's for each of the quality classes each of which again is based on EQR's for the chosen indicators. HEAT has been successfully applied in a Danish intercalibration study comprising Odense PRB and 13 other Danish marine areas. From this, the following specific conclusions can be emphasized:

Determinination of reference conditions should as much as possible be based on historical data and numerical modelling and as little as possible on expert judgement (the latter comprised only 4% in this exercise).

It is recommended to use as many indicators as possible within each quality element to make the classification robust and lessen any misclassification. Weighting between indicators should be applied simply because all available information should be used (e.g. distinguishing 'strong' indicators), although the actual outcome in this particular exercise was relatively unaffected.

The normative definitions of the WFD should be translated into numeric class boundaries by a scientific approach and independently of political interests (just like the setting of RefCon).

Although conclusions are still missing, use of a Good/Moderate class boundary of 50% is likely beyond the definition of a moderate deviation from RefCon sensu the WFD and is not adequately documented. The acceptable deviation from RefCon should accordingly be less then 50%, e.g. 15% or 25% as tested in this exercise.

The outcome of the classification by HEAT is identical to earlier assessments of Odense Fjord and other Danish coastal areas especially when the more stringent scenarios (15 or 25% acceptable deviation from RefCon) is applied.

HEAT can be modified into a tool that both can assess 'ecological status' sensu WFD and 'conservation status' sensu the Habitats Directive (and further also perform assessment in relation to the new Marine Strategy Directive).

Joint implementation of all directives can be strengthened by developing assessment tools, like HEAT, that will seek to converge the different assessment procedures.

About Phase II of the Pilot River Basin Activity

Since the adoption of the Water Framework Directive in 2000, a Common Implementation Strategy (CIS) was set up to guide its implementation. In a first phase a set of guidance documents were prepared, which were tested by the Pilot River basins. The outcome of this exercise is reported in the 2005 Pilot River Basin Outcome report. In the second phase – running from 2005-2006 and coinciding with the third CIS work programme - the Pilot River Basins have been involved in the different working groups and other activities set up in the CIS, and a wide variety of topics have been subject to pilot exercises. More information can be found on the European Commission's Directorate-General for the Environment Website:

http://ec.europa.eu/environment/water/index.html

The views expressed in this report do not necessarily reflect the views of the European Commission. The contents of this report has not been assessed by the Commission for compliance with the requirements of Directive 2000/60/60, and practices described in the report may therefore not necessarily be compliant with those provisions.

III.5. COST EFFECTIVENESS ANALYSIS

*This report was prepared by the Pilot River Basins, **Odense** (DK),**Jucar** (ES), **Gascogne** (FR), **Harjiu** (EE), **Suldal** (N) and **Weser** (DE). More information about these river basins can be found in chapter II or at: http://ec.europa.eu/environment/water/water-framework/prbs.htm. The report addresses (one) specific aspect(s) of the common implementation strategy for the Water Framework Directive (Directive 2000/60/EC), as part of the second phase of a pilot basin river activity.*

III.5.1. Introduction

The Water Framework Directive requires economic aspects to be looked at while implementing the Water Framework Directive. The selection of cost-effective combination of measures to be included in the programme of measures is one of the main issues in the process of elaborating the RBMP. Several Member States and River Basins have established CEA methodologies that facilitate the selection of measures. These methodologies are in general based on cost estimates and refer to certain pressure groups.

Specific cases will require a broader analysis that includes also socio-economic costs. And additionally, costs of measures have to be considered if the proportionality of costs according to Art. 5 is an issue.

The PRBs demonstrate examples of CEA for their basin and specific pressures identified, but also economic aspects that need to be dealt with selecting mitigation measures.

Relevant requirements of the Water Framework Directive

According to the WFD each Member State shall ensure the establishment for each river basin district, or for the part of an international river basin district within its territory, of a programme or measures, taking account of the results of the analysis required under art. 5, in order to achieve the objectives established under art. 4 (art. 11.1)"

Article 5 requires analysis in accordance with Annex III, which amont other things state that :

The economic analysis shall contain enough information in sufficient detail (taking account of the costs associated with collection of the relevant data) in order to: […]

(b) make judgements about the most cost effective combination of measures in respect of water uses to be included in the programme of measures under Article 11 based on estimates of the potential costs of such measures.

III.5.2. Odense PRB: State of Play for Cost-Effectiveness Analysis in the Water Framework Directive

The main pressures on water bodies in Odense PRB is loss of nutrients (nitrogen (N) and phosphorous (P)) from agriculture and, to a lesser extent, impacts from sewage water. As shown in table 7, the risk analysis shows that "good ecological status" will not be reached for the main part of the water bodies in the river basin with basic (already planned) measures, before 2015.

The preparation of a cost-effective management plan and programme of measures to meet the objective of "good status" in coastal waters, lakes, watercourses and groundwater in the river basin, is based on an integrated analysis of operational objectives for these water bodies, and cost and effects of measures at play, to meet these objectives. This is done using the knowledge base at hand today and is described in the following.

It has been possible to quantify target reductions for each recipient and also reduction effect of various measures as regards nitrogen emissions. This makes it possible to carry out an integrated cost-effectiveness analysis of measures with reduced nitrogen emissions as main or sole effect and, hence, to rank and implement measures accordingly.

Table 7. Results from risk analysis.

Odense Fjord Catchment	Water bodies at risk	Main Pressures Reasons for not fulfilling objectives	Operational objectives in excess of baseline measures
Watercourses/ rivers	96%	Physical and hydro-morphological conditions Regulation of river and river valleys due to land reclamation for agricultural purposes Waste Water outlets storm water, scattered settlements	Discontinued maintenance (regular weed cutting and sediment removal) and rewinding of watercourses
Lakes	86%	Nutrient loads from agriculture	Total reduced P-load of ~1 tons/year Total reduced N-load of ~50 tons/year (11 largest lakes)
Coastal waters (Odense Fjord)	100%	Nutrient Loads from agriculture Hazardous substances	Reduced N-load of ~1.000 tons/year Reduced P load
Groundwater tables	50%	Pesticides, other hazardous substances and nitrate load High abstraction levels	N-leaching from root zone in nitrate sensitive areas < 25 mg/l. Measures to reduce N-leaching necessary in 1/3 of nitrate sensitive areas. Measures at play will also reduce pesticide loads.

For phosphorous it has been possible to quantify the needed reduction, but the effect of measures in terms of leaching and run-off is uncertain due to questions of retention and time-lag. Specific measures in fixed dosages or quantities estimated to achieve the necessary effects as regards reduced phosphorous loads to the water environment are included in the analysis.

Another type of parameter for achieving good status is related to physical and hydro-morphological status of water bodies (mainly watercourses/rivers). Hydro-morphological structures in watercourses fulfilling the objectives can mainly be achieved through one type of action, namely, discontinued river maintenance (weed cutting etc.), re-winding and to allow free meandering of the watercourses/rivers.

III.5.2.1. Down-stream effects

Analyses for the management plan are undertaken for 12 sub-catchments (11 smaller catchment areas for 11 lakes and the residual catchment area for Odense Fjord) and 5 ground water reservoirs. The catchment areas of Odense River Basin, including retention factors used for the purpose of this analysis, are illustrated in figure 21.

Special attention has been given to carry out an integrated POM, i.e. integrating the interactions between sub-catchments/water bodies in the river basin. To ensure coherence between the sub-catchment analyses, programme of measures in most up-stream sub-basins are identified first, then evaluating the impact that these measures have on down-stream sub-catchments etc. Obviously, these are quite simplified assumptions regarding hydrology and ecological synergy-effects. With this approach, however, it is possible to work with individual retention factors between as many catchment areas as selected.

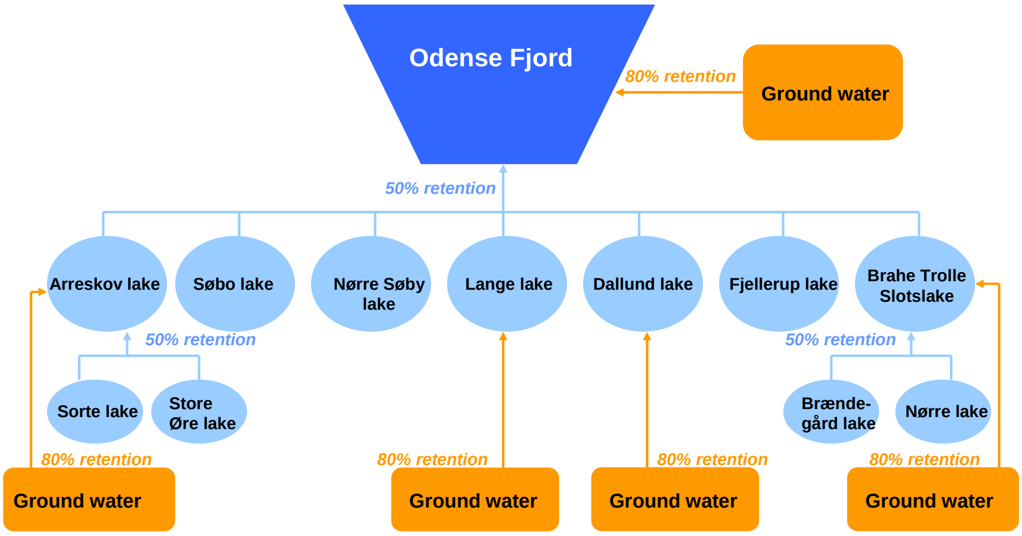


Figure 21. Simple illustrations of catchment areas and retentions used in the analysis.

III.5.2.2. Which measures and in what dosage?

The focus has been on technical measures and not economic or fiscal instruments (i.e. not on *how* to implement the measures/POM), assuming that the choice of instrument is largely of political consideration.

Both basic and supplementary measures are analysed in conjunction. Basic measures include measures that are being implemented through existing regulatory planning and control processes, i.e. the third Danish Action Plan for the Aquatic Environment (2005) and regional environmental planning (2001-2013). The effects of basic measures are integrated in the analysis to identify the need for supplementary action to achieve "good status", and to "identify" potential interaction between basic and additional measures. More than 40 different measures have been identified. Measures that can address the pressures in the river basin by removing, relocating or reducing the pressures, or remedy the impact of the pressures by carrying out restoration work. The identified measures are categorized as measures to

- ✓ Increase environmental efficiency in agriculture (e.g. 5% increase in utilization of animal manure)
- ✓ Set-aside (e.g. forestation, wetlands or permanent grassland)
- ✓ Set-aside with regard to physical and hydro-morphological improvements in rivers (recreation of wetlands and grassland in river valleys combined with discontinued maintenance and rewinding of regulated rivers)
- ✓ Improve quality of groundwater
- ✓ Reduce pollution from point sources

The identification and determination of available measures is based on local expert judgement to distinguish between theoretical and practically possible measures in terms of cost and effectiveness. A maximum dose of each measure in each catchment area is set (e.g. numbers of hectares of agricultural land that can be converted to wetlands, or number of houses that could be connected to the collective sewage system). Special attention has been given to overlapping measures and to avoid double counting of potential dosages.

III.5.2.3. Evaluating the effectiveness of an individual measure

Data gathering on effects and unit-costs of measures has been a significant part of the analysis, since no national database has been available for these data at the time of the analysis. Emphasis is put on effectiveness of individual measures, defined in terms of reductions in nutrient (N) discharges into surface water (emission reductions) and mainly based on review of available data from national work on the third Action Plan for the Aquatic Environment (2005) which includes scenarios for Odense RB. In some cases estimates on effects based on more local knowledge is used, e.g. from extensive monitoring work carried out by the County of e.g. wetland restoration projects. As regards effectiveness of area related measures/diffuse pollution to surface waters, a differentiation in retention coefficients has been made between measures implemented in river valleys (low retention) and higher grounds (high retention).

III.5.2.4. Estimating costs

Due to changes in CAP in particular, and, among other things, due to increasing marginal abatement cost of waste water treatment in Denmark, several costs of measures had to be estimated. All costs are presented in terms of annual equivalent costs. A distinction is made between financial costs (actual expenses experienced by certain groups of society, e.g. farmers) and socio-economic costs (costs to society, i.e. effects on all groups of society). The socio-economic figures form the basis of prioritisations and hence, combinations/programme of measures, while financial figures can be used to evaluate distributional consequences of implementing programmes of measures in the river basin.

The socio-economic cost calculation should also take into account the indirect (non-water related) effects of measures. This is, however, complicated mainly by the fact, that available data is insufficient when it comes to estimates of the socio-economic value of many of the indirect effects relevant here such as a change in recreational values of afforestation, or existence value of a change in biodiversity. As a consequence cost-estimates without side-effects are used as the basis for the cost-effectiveness evaluation. The programmes of measures are then reviewed according to a qualitative description (quantification/valuation if possible) of the side-effects of the measures. The prioritisation of measures can then be altered on the basis hereof.

III.5.2.5. Determining the most cost-effective strategy

The aim has been to ensure cost minimisation of a management plan for Odense RB. For the management plan as a whole, cost-effectiveness is achieved through comparison of the total cost of alternative combinations of measures in various dosages, at various geographical positions in the River Basin. As mentioned, only nitrogen could be optimised with regard to cost-effectiveness of measures, while measures to achieve good status with regard to other parameters have been included as fixed dosages of specific measures.

A relatively pragmatic solution with manual iterations in a spreadsheet has been used to evaluate combinations of measures. The situation with relatively few recipients and interrelations between placing of measures and environmental impact and economic costs, respectively, can be used successfully in connection with the management plans needed for WFD implementation. However, a relatively low degree of geographical detail does not guarantee fulfilment of targets at water body level. This is addressed by setting a minimum dosage for certain measures in each of the 12 catchment areas and ground water reservoirs. Since all data is gathered in a spread-sheet and the manual iterations give a real sense of the mechanisms at play, this approach is very transparent. The spread-sheet based model gives the opportunity for interactive scenario building, where the results of a change in the combination of measures is immediately clear. The analysis of economic consequences of implementing the WFD in the river basin, comprehend two different scenarios based on different packages of measures. A baseline scenario with basic, already planned, measures is analysed according to costs and effects in order to define the reference situation. The two WFD scenarios include costs and effects of measures necessary to achieve "good status" in relation to other parameters than nitrogen such as physical and hydro-morphological status, phosphorous, etc. (scenario 0). The dosages of these measures are fixed in the analysis. The two scenarios aim at target fulfilment in all catchment areas and groundwater, and are described below.

III.5.2.6. Scenario 1 - Mixed scenario

Importance attached to increased environmental efficiency in agriculture. Combination of measures related to agriculture aimed partly at increased environmental efficiency in agriculture and partly at set aside. The most cost-effective measures are estimated to be that of *"increased utilization of animal manure"* (14-38 DKK/kg N) (1 DKK=0,13EUR), *"catch crops"* (11-29 DKK/kg N) and *"reduced N-norm application in river valleys"* (29 DKK/kg N).

Scenario 1 results in a change in agricultural practice on approximately 19 % of cultivated land area. Cultivated area is converted to forest (2%), wetlands (8%) (includes 3% needed for set-aside for wetlands in relation to physical and hydro-morphological improvements in watercourses) and permanent grassland (9%) as supplementary measures to fulfil WFD targets.

III.5.2.7. Scenario 2 - Wetland scenario

Importance attached to set aside. This scenario comprehends a conversion in agricultural practice on approximately 23% of agricultural land area. It is estimated to be more cost-effective to set aside agricultural land in low land areas (e.g. river valleys) than on higher grounds.

Scenario 2 is, to a considerable extent, based on *"set aside for wetlands in river valleys"* (9%), which is among the most cost-effective measures (42 DKK/kg N), and *"permanent grassland"* (121 DKK/kg N) (8%), as additional measures to fulfil WFD targets. *"Afforestation"* makes up 3%. An additional 3% of the agricultural land area is needed for set-aside for wetlands in relation to physical and hydro-morphological improvements in watercourses.

III.5.2.8. Provisional results

A spread sheet model prepared specifically for the purpose of the analysis, including data on potentials, effects and unit costs of measures, is used to analyse the economic and environmental consequences of the alternative scenarios. Provisional results of the analysis are shown in the following table.

The analysis shows that it is possible to meet the objectives of the WFD by reducing the annual nitrogen input to the recipients corresponding to a reduction in order of magnitude needed to fulfil the objective of good status. The analysis shows that it is possible to implement environmental measures within agriculture that will reduce nitrogen loading of Odense Fjord by 1,000–1,200 tons per year (including basic measures). This is done without reducing livestock production in the river basin. However, a reduction in cultivated area of 20-24% will necessarily result in reduced crop production.

Costs connected to the baseline scenario are higher than costs of supplementary measures necessary to fulfil requirements of the WFD (scenarios 1 and 2). It is noted here that costs connected to baseline are costs of already planned measures that have not been fully implemented yet. In this way, baseline does not include costs of fully implemented measures within the last 20 years and before that.

Measures to reduce point source pollution take up a considerable part of baseline costs. It should be noted that for all scenarios, measures to reduce point source pollution aren't implemented to reduce nitrogen loads to the aquatic environment, but to fulfil objectives as regards pollution of watercourses, lakes and marine waters with oxygen consuming organic substances, phosphorous, hazardous substances etc. Scenario 1, which is mainly based on increased environmental efficiency in agriculture, is 6 million DKK (0,8 million EUR) more expensive on an annual basis, than scenario 2, which is mainly based on set aside. This could indicate that set aside is a less cost-effective solution than the implementation of measures to increase environmental efficiency in agriculture. However, administration costs of such measures have not been addressed. In this way, it seems to be a relatively small difference in costs between the two scenarios. There is a tendency that measures for set aside have generally become cheaper, and measures to improve environmental effectiveness have become more expensive, compared to the unit costs used in the analysis.

The total costs of the two scenarios (94 and 100 million DKK per year (12,2 and 13 million EUR), respectively) can be compared to the cost of already implemented measures on sewage treatment within the catchment, which is in the order 300 million DKK per year (40 million EUR), and the costs of already implemented measures reducing nutrient loads from agriculture, of approximately 7,5 million DKK per year (1 million EURO per year).

In areas encompassed by other directives, e.g. areas designated as NATURA 2000-areas, further measures will, in many cases, be necessary to ensure fulfilment of specific requirements of these directives, e.g. "good conservational status" in the Habitats Directive. An analysis of an alternative scenario that includes additional consideration for target fulfilment for terrestrial natural habitats (both wet and dry) in NATURA-2000 designated areas, and for fulfilment of objectives within the regional planning system and of the RIO-agreement concerning preservation of biodiversity, is in preparation. The assumption is, that an integration of considerations about placement of measures such as wetlands and permanent grassland, and co-ordination of this placement with soil conditions and occurrence of already existing natural habitats, could potentially result in some additional expenses being avoided compared to measures to meet objectives for natural habitats being seen as separate to the WFD.

Table 8. Overall provisional results of the cost-effectiveness analysis, Baseline and Scenarios 0, 1, 2.

	Baseline	Sc. 0[1]	Sc. 1	Sc. 2
Socio-economic annual costs, 1.000 DKK (1 DKK = 0,13 EUR)				
Total	126.000	59.194	93.965	100.117
Increased environmental efficiency in agriculture	3000	9	6.461	7
Set aside	5000	8.942	22.430	35.035
Set aside with regard to physical and hydro-morphological improvements (watercourses)		10.338	10.338	10.338
Measures to improve the quality of groundwater		0	14.832	14.832
Measures to reduce point source pollution	118.000	39.904	39.904	39.904
N-reduction in 12 recipients, tons				
Total	342	280,2	937,3	937,1
Increased environmental efficiency in agriculture	167	0,3	297,6	0,2
Set aside	145	43,7	355,7	653,0
Set aside with regard to physical and hydro-morphological improvements (watercourses)		203,5	203,5	203,5
Measures to improve the quality of groundwater		0,0	44,1	44,1
Measures to reduce point source pollution	18	7,8	7,8	7,8
Indirect effects from other lake catchments	12	25	29	28
Average cost-effectiveness (DKK/kg N)				
	381	232	103	110
Set aside				
Ha set aside*	1.279	5.959	13.758	16.731
Percentage of total agricultural area	2%	7%	19%	23%

[1]Scenario 1 and 2 include scenario 0 measures

*set aside includes conversion of agricultural practice to e.g. forest, wetlands or permanent grassland

III.5.3. Jucar PRB: Cost-effectiveness Analysis Report

III.5.3.1. Overview of the ongoing CEA process

The work done so far in the Jucar PRB has focused on the calibration and development of integrated simulation models for the assessment of the effects of different combinations of measures on water quantity, water quality, and economics in the basin. Figure 22 represents the different steps involved in the CEA process in the Jucar River Basin in Spain.

An important effort was done for the Art. 5 report in analyzing pressures and impacts, as well as the potential gap in water status between the baseline scenario and the Directive's objectives in those water bodies at risk of not achieving the good water status. A realistic simulation of the effect of the measures on water flows and water quality, and the assessment of their economic impacts are fundamental steps in the development of a meaningful CEA procedure. Once this is accomplished, an optimization procedure can be applied to select the least cost combination of measures to achieve the environmental objectives.

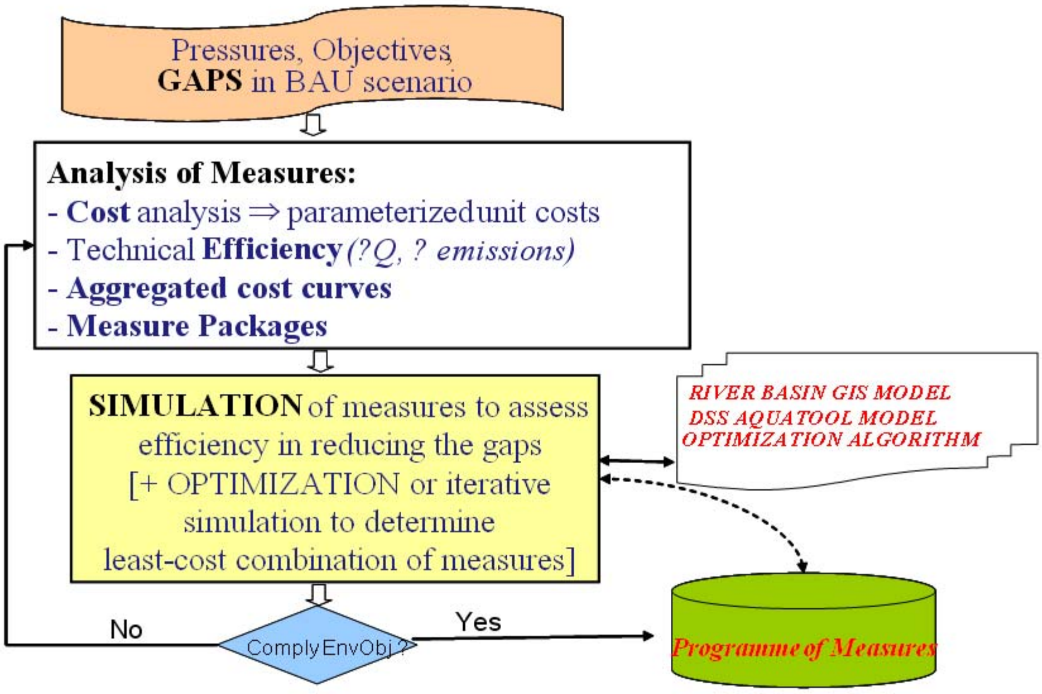


Figure 22. CEA Process in the Jucar PRB.

III.5.3.2. Serpis River Basin Integrated Simulation Model

A pilot detailed simulation model of the Serpis River Basin (990 km^2), within the domain of the Jucar PRB, has been developed using AQUATOOL, a generic software package that allows to build decision support systems for integrated analysis of water resources systems (Andreu et al., 1996). The model integrates surface and groundwater resources, demands, and hydraulic infrastructure. Water allocation and operation decisions are made each monthly time-step according to demand targets, resource availability and predefined operating rules (priorities).

The model can be used to simulate water quantity management, but also water quality. Eight constituents - conductivity, dissolved oxygen, organic matter, different forms of nitrogen, and phosphorous- can been modelled. Different management alternatives can be tested for improving environmental conditions. Finally, a hydro-economic model of the basin has been developed, incorporating economic value functions for the different water uses and variable operating costs.

III.5.3.3. Assessment of the effect of measures on water quality, quantity, and economics

The effect of measures to reduce the quantity pressure on the resources (e.g.., demand management, increase in efficiency in irrigation or urban supply, increase in supply through non-conventional resources or water transfers, etc.) will be an increase in streamflow, and therefore, a reduction of the pollutants' concentration. The assessment of the streamflow increments requires considering the changes in return flows, stream-aquifer interactions, losses (evaporation and seepage), etc., in the different interconnected water bodies of the system, which we assess with the support of the integrated simulation model (see figure 23).

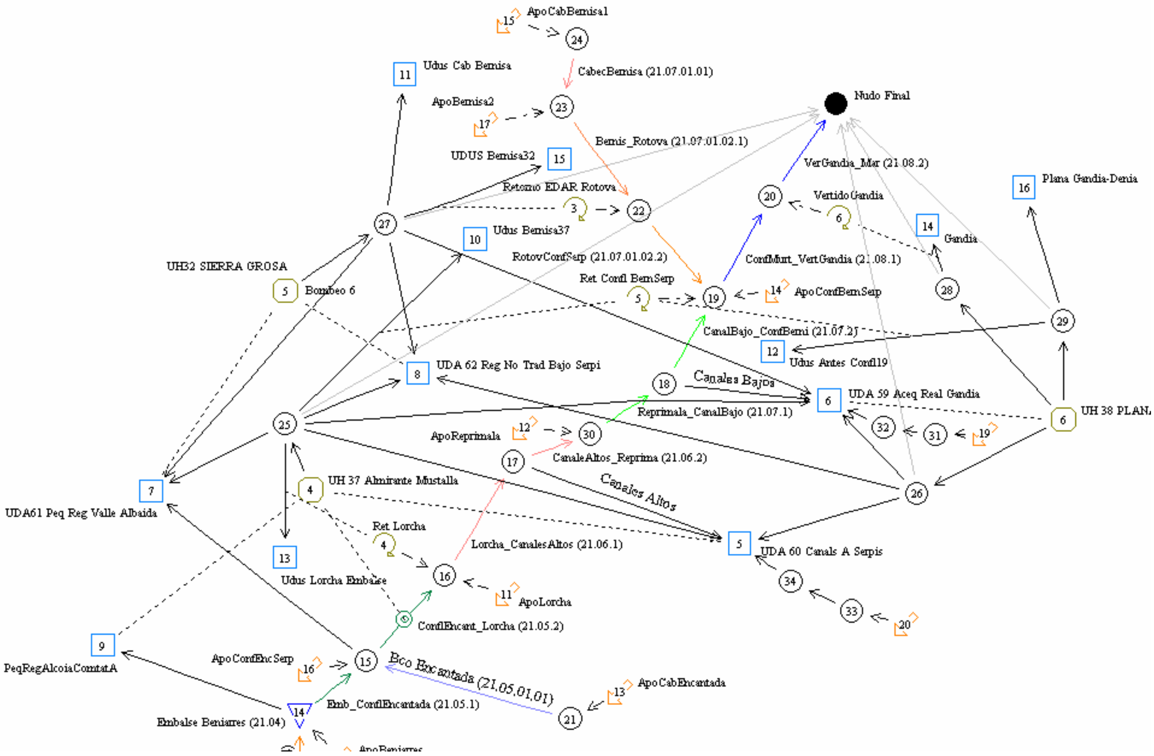


Figure 23. Serpis River Basin simulation model, downstream Beniarrés reservoir.

Since emissions are what can be controlled, but the pollutant concentration or other water quality indicators are the target (as a proxy of good status), they must be related. In the Serpis RB model, this relation is defined through a previously calibrated water quality simulation model. A GIS-based distributed simulation model of the hydrologic cycle, including natural runoff and groundwater flow, is already operative to determine the relation between the reduction of nitrogen emission and the reduction of nitrate loads in rivers and aquifers. On the other hand, a model for simulation of water quality in rivers and reservoirs allows us to model the changes in nitrates and phosphorus concentration and their relevance on eutrophication processes. By means of these simulation models, a relation between emissions reductions and pollutant concentration reduction can be found for any combination of measures. Through this procedure we plan to analyze the evolution of water quality under different scenario, the effects of future water treatment facilities, or the requirement of additional flows for improving water quality at critical points.

The hydro-economic model developed for the basin allows us to assess the economic impact of measures and management strategies as changes in consumer surpluses of the water demands in the basin. Through the hydro-economic model, changes in streamflows can be translated into changes in water delivered to the different water demands, which are evaluated as economic losses using the corresponding economic demand functions. On the other hand, the cost of certain measures, as for example, maintaining a minimum ecological streamflow in a certain reach of the river, has to be determined in terms of its opportunity cost. As a supporting tool for the analysis, a GIS-based model of the basin has been developed to help to reproduce the spatial detail of the pressures-impacts processes (see figure 24).

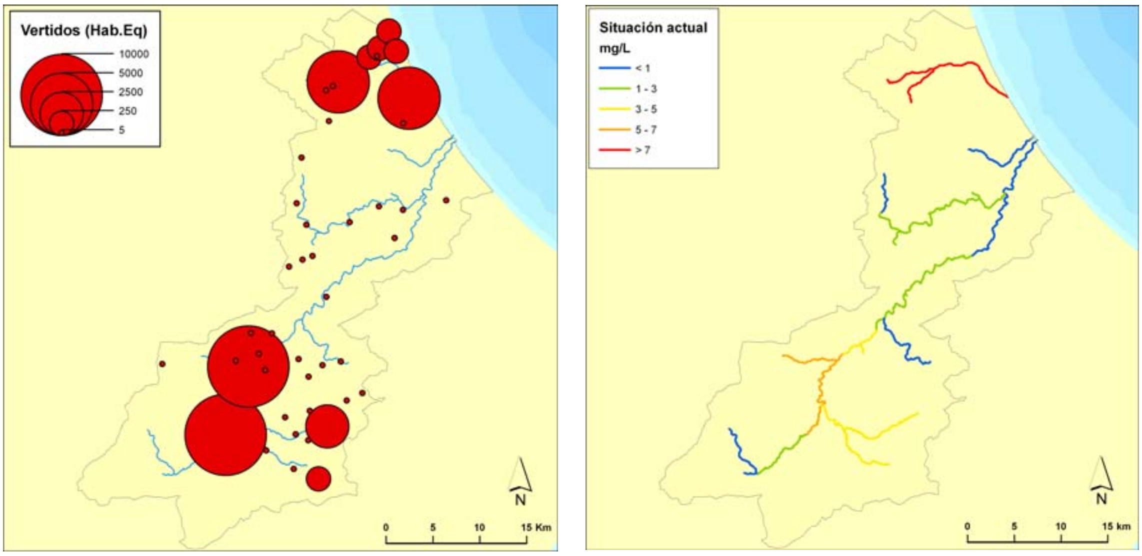


Figure 24. Serpis River Basin GIS simulation model.

III.5.3.4. Results and timeframes

The application of the tools described to a CEA process is currently being tested in the Serpis pilot case through a cooperative project with researchers of the Technical Univ. of Valencia and the Univ. of Valencia, Spain. First results include a comprehensive integrated simulation model of monthly water management in the basin, and the integrated simulation of BOD with first-order decay functions. A group in the Spanish Ministry of Environment is working to develop a catalogue of measures and the corresponding financial costs. A next step in the methodology is the development of an iterative process that would combine the results of a simplified optimization model to suggest least-cost combinations of measures with their more precise simulation through the detailed models that have been developed. Preliminary results of identification of the program of measures for the Serpis River are expected in March 2007.

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III.5.4. Gascogne PRB: Cost-effectiveness analysis in the Gascogne rivers basin

III.5.4.1. The PRB District Context

The context of our PRB is the Adour-Garonne District working plan. We have to elaborate the first programmes of measures (PoM) including their cost appraisal, and a first cost-effectiveness analysis (we will probably just carry out a first step in this field).

The following methods will be used:

- first local experience gathering and sharing,
- first qualitative assessment of effectiveness,
- pilot studies like PRB.

Local partners are involved in the PoM elaboration by:

- sharing diagnostic, stakes and results,
- leading the choice and the combination of measures,
- submitting the proposal to a territorial committee,

with the following planning:

- elaboration of PoM drafts for all the hydrographic unities of reference (Gascogne Rivers are one of them with several water bodies) by January 2007, submitting them to the Adour - Garonne District committee in March 2007 and to the public consultation from September 2007 to February 2008.

III.5.4.2 The PRB objectives

The PRB objectives concerning cost-effectiveness analysis are to implement a step by step approach. In 2006-2007, a first step will be:

- to appraise the cost of preventive measures such as:
    - agri-environmental measures linked with the Common Agricultural Policy (CAP) and the European Agricultural Fund for Rural Development (EAFRD), with contracts for 5 years for reducing nitrogen inputs and balances, for reducing pesticides inputs, for implementing buffer strips (an obligation with the new CAP since 2005)…,
    - investments,
    - advice and training
- to compare cost-effectiveness between preventive measures and curative treatment programs concerning drinking water resources,
- to combine economic analysis with sociological studies. By using this link between both analyses, we wish to understand what our local partners and farmers' motivation is in implementing actions that lead to the reduction of agricultural diffuse pollutions. The results of these sociological studies will be available in 2007.

III.5.4.3. Our main difficulties and our needs

The cost-effectiveness analysis is a new subject for our local partners. They misunderstand the methods and can be afraid of them if they seem complicated. We have to "translate" them so that they can be interested by these analyses.

To implement them, we need:

- the most practical tools and methods,
- to begin local studies on the most relevant points,
- to share European experience and knowledge.

III.5.5. Weser PRB: Aspects for the identification of environmental objectives and the selection of measures: Salt pressures of the potash mining industry in the Weser River Basin

III.5.5.1. Introduction

For about 100 years salt mining for the potash industry has been taking place in the Weser River Basin. As only a part of the mined salt can be used in the production process, large amounts of salt waste need to be dealt with. The mining and potash industry sites are located in the Aller-Leine area in Lower-Saxony with one production facility left, in Neuhof on the river Fulda and in the Werra area in the federal states of Hesse and Thuringia (fig. 25 top). The production facilities in the Werra area are causing the main salt discharges into the Weser River Basin with 1.5 Mio. t/y of Cl, the river Aller carries 0.4 Mio. t/y of Cl, and the Fulda 0.08 Mio t/y of Cl. Moreover, there are other industrial and residential sources, but the major part of salt inputs can be attributed to the potash industry.

Overall there are eight surface water bodies of the Werra and the Weser affected, covering a length of approximately 500 km, to an extent that decreases with the diluting effect of unpolluted tributaries. The salt pressure also has an impact on groundwater bodies in the mining and production area.

To deal with the salt pollution in the context of the WFD, its history has to be taken into consideration. Immense potash waste heaps and the deep well disposal of waste brine into the geological horizon of the Plattendolomit with its clay layers have caused, and will continue to cause diffuse pollution of groundwater. This diffuse input, in addition to the direct discharge into surface waters from the industrial process, have to be considered when deriving objectives and identifying possible measures.

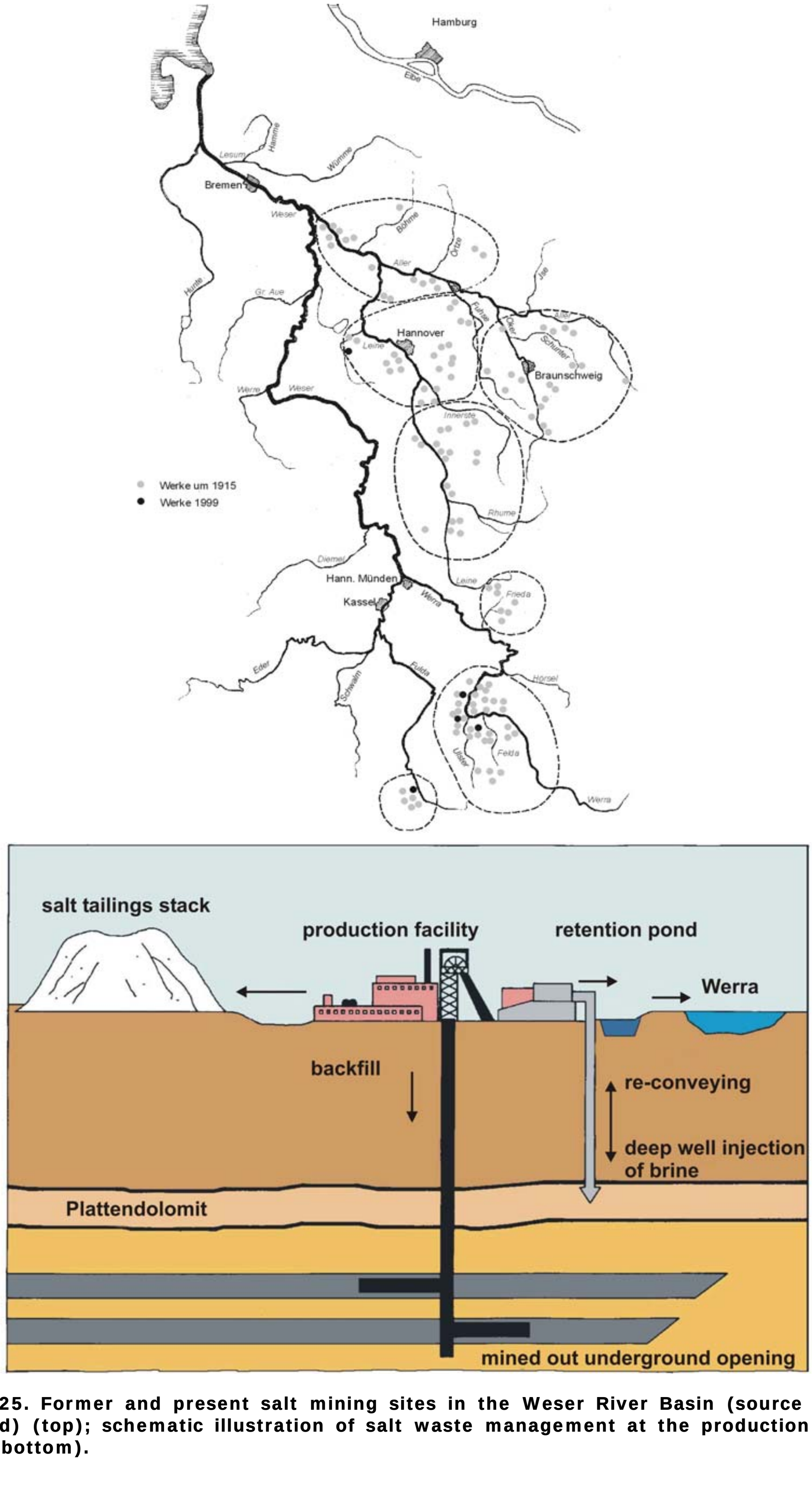

Figure 25. Former and present salt mining sites in the Weser River Basin (source Tjaden, modified) (top); schematic illustration of salt waste management at the production facility Werra (bottom).

III.5.5.2. Implemented measures for the reduction of salt waste pollution

In 1913 the Potash Waste Commission was summoned for the first time and concluded by treaty the limitation of chloride input. In the following years limit values were raised. The limit value of 2,500 mg Cl/l at measuring station Gerstungen was maintained up to the 1960s. The chloride pressure on the Werra and the Weser had its peak with concentrations rising up to 20,000 mg Cl/l during the 1970ies/1980ies when the production facilities of the former GDR stopped the deep well disposal (figure 26). In the 1980ies in the Federal State of Hesse the production technology causing large amounts of waste water was changed to a solid waste technology. Consequently, the chloride discharge was reduced. However, the change of waste disposal resulted in the formation of potash waste heaps. After the German reunification two production facilities in Thurinigia were closed and, supported by funds, the potash processing technology was modernised which led to the reduction of the chloride concentration by approx. 90%. After 40 years the limit value of 2,500 mg Cl/l is complied with since May 1999.

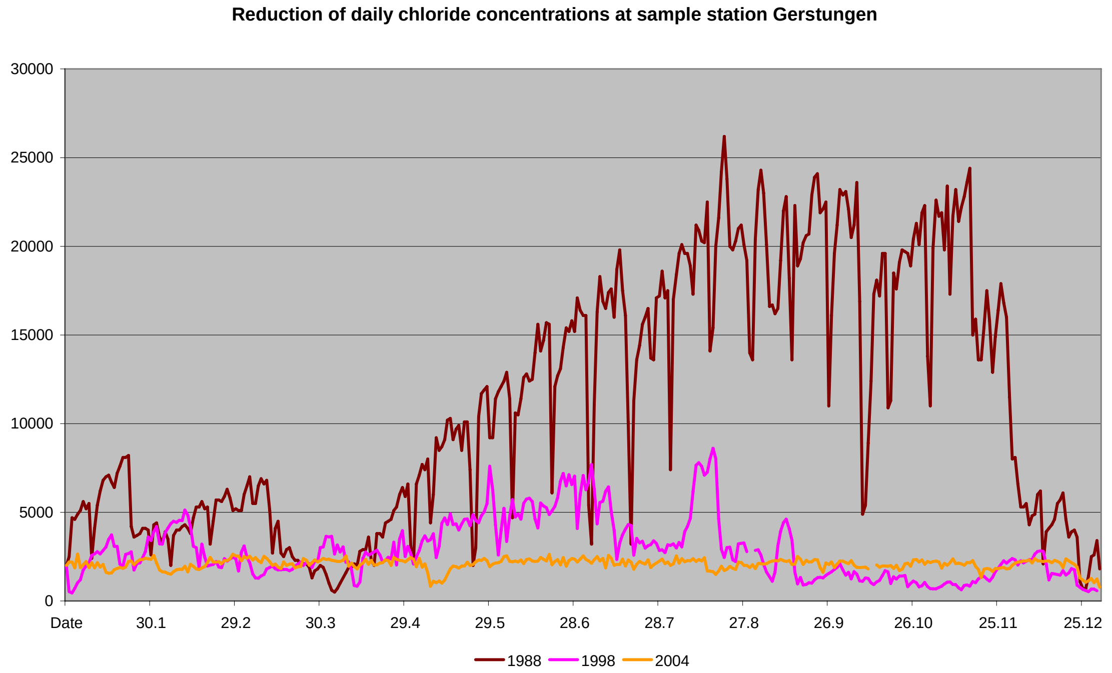

Figure 26. Past and present daily chloride concentration at sample station Gerstungen/Werra [mg/L].

III.5.5.3. Further measures and possible objectives

Leveling of salt load

For further improvement of the status of surface and groundwater bodies an extensive analysis of factors and conditions is necessary. First of all, there is continuous diffuse pollution caused by both anthropogenic and natural sources which cannot be regulated. Additionally, the liquid and solid salt waste is disposed of via different paths and, furthermore, waste water from potash heaps and production process emerges. Solid residues at the production facilities in Hesse are disposed of on salt tailings stacks; in Thuringia the waste is placed into underground caverns. Liquid residues are discharged via a storage reservoir to balance out the salt waste load of the Werra. If the concentration gets too high, the waste is initially injected underground and during high water flow rates disposed of into the river (Fig. 22 bottom). By managing the disposal of the salt waste input of the three production facilities in the Werra area, a total immission limit value of 2,500 mg/l of Cl is observed constantly at the downstream sample station of Gerstungen.

The chloride concentration in the Werra is significantly higher than under natural conditions which are assumed to be less than 100 mg/l (Tjaden 1915). Looking merely at the chemical conditions, concentrations below 200 mg/l were classified by the LAWA (German Working

Group of the Federal States on Water Issues) as "good status". It is not clear what chloride concentration will actually lead to the good ecological status required by the WFD. However, investigations in the past have given rise to the conclusion that the concentration could possibly be higher than 200 mg/l.

Good ecological status depends on a variety of chemical and hydromorphological parameters. Therefore, the research carried out by the operator needs to be analysed further. Beside the fact that the chloride concentration should be as low as feasible, balanced conditions which the organisms can adapt to should be established.

In looking for a possible target value for a levelled chloride load, the existing unalterable input from diffuse sources which is caused by former disposal methods and the hydrological conditions (runoff) have to be taken into account. There is a diffuse input from the potash mining area in Hesse and Thuringia of approx. 17 kg/s. With an average medium runoff of 30 m³/s of the Werra downstream from the potash input, the mean concentration amounts to approx. 570 mg Cl/l. Consequently, depending on the runoff, for concentrations in the Werra a fluctuation ranging from 60 to 2,220 mg Cl/l can be assumed. It becomes obvious that the pressure is high even without the input from the ongoing production process.

With the assumed steady diffuse pollution of 17 kg/s and a maximum input from production facilities of 300 kg/s of Cl for varying runoff levels, a number of days per year can be assumed at which the limit value is exceeded or not reached. On the supposition that it has the same ecological impact if the concentration differs from the ordinary input either way, counting these days of derogation there will be an optimum of least days at 2,000 mg/l (figure 27). Aiming at a balanced chloride concentration and assuming that there will be a continuous diffuse pollution of 17 kg/s which cannot be influenced, the optimal concentration would be around 2,000 mg/l.

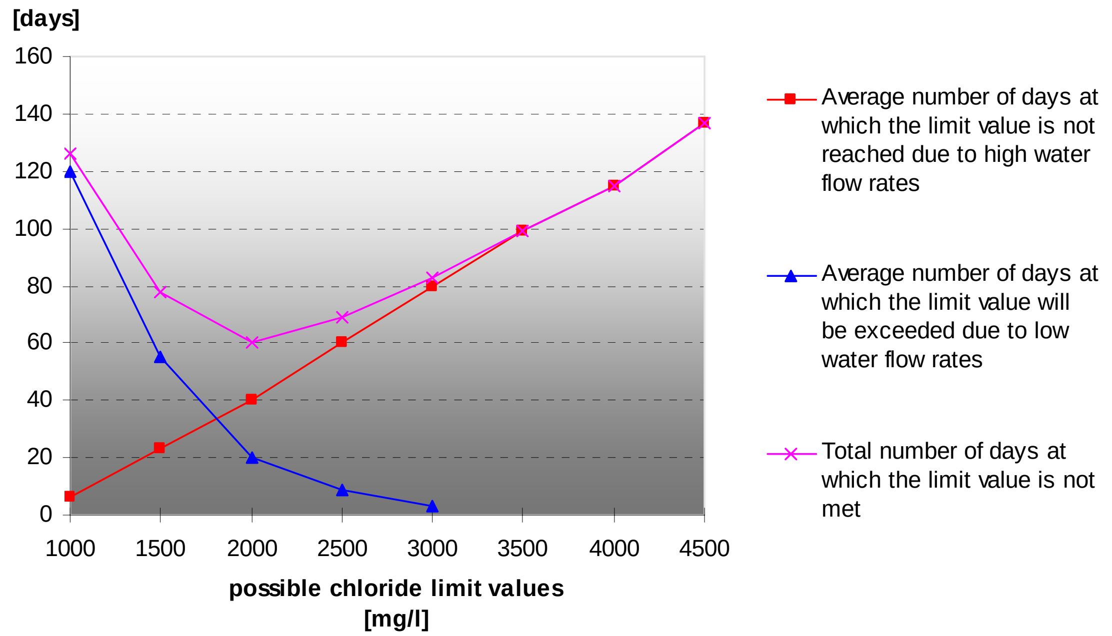

Figure 27. Number of days limit value cannot be met.

Improving the status of water bodies downstream

As described above the water bodies of the Werra directly below the point of diffuse input of salt waste will not achieve good ecological status during any conceivable timeframe. Nevertheless, the impact of reduced limit values on water bodies of the Werra and the Weser further downstream should be looked at. Research during the 1990ies has shown that below a concentration of 700 mg/l organisms immigrate from neighbouring unpolluted rivers and establish relatively stable populations. This preliminary assumption has to be verified by research and experience. Figure 28 presents the example of an assumed limit value of 700 mg/l chloride at sample station Gerstungen. Decreasing the limit values will lead to moderate conditions regarding chloride in a longer reach of the river. A significant improvement seemingly occurs when reducing the limit value from 4,500 mg/l to 2,500 mg/l. A further reduction of the limit value below 2,500 mg/l would not improve the status in Gerstungen or further downstream considerably. This is owed to the fact that the water of the river Fulda that confluences at km 365 with the Werra dilutes the salt concentration.

To reduce the limit value for Gerstungen further in order to achieve a concentration that enables better ecological conditions would result in the exceeding of the limit value by the constant diffuse pollution alone at numerous days per year.

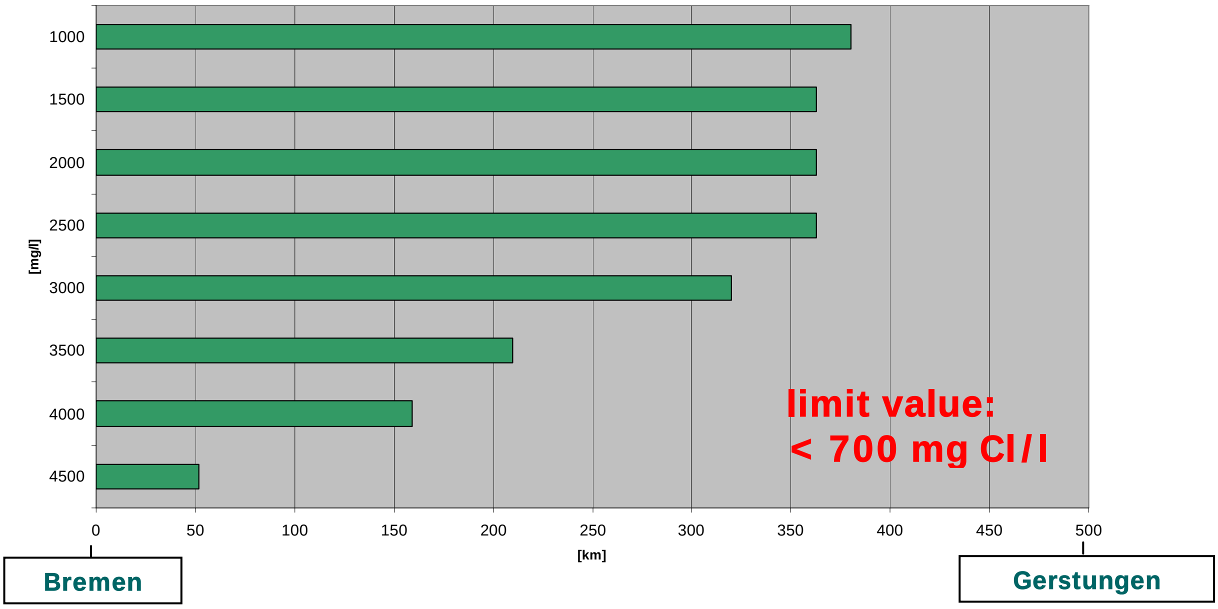

Figure 28. River length with moderate conditions regarding salt concentration in correlation to limit value at sample station Gerstungen.

Selection of further technical measures

A range of measures are being considered systematically at present and evaluated with respect to their effects and costs. First results are expected by the end of 2006. Figure 29 shows the different categories of measures which reduce the salt input at its source.

Initially a catalogue of possible measures was compiled which was then analysed with respect to technical feasibility, benefit and cost effectiveness. Subsequently, a combination of cost effective measures will be determined. The cost effectiveness analysis will provide valuable information for the identification of environmental objectives. Looking at costs and effects of measures, wider economic consequences and the proportionality of costs will be considered.

Presently planned is the relief of smaller tributaries of the Werra in the mining area. E.g. waste water that is discharged into the river Ulster will from 2007 be disposed of via a tube directly into the Werra and from 2012 the river will be free of salt.

III.5.5.6. Conclusions

The preparation of the river basin management plan requires an analysis of possible solutions to improve the salt pressure in the Werra and the Weser considering cost effectiveness, technical feasibility and proportionality of costs. Feasible measures for acceptable costs need to reduce the salt pollution effectively and the improvement of the ecological status needs to be verified. In a pilot project possible measures are considered at present, associated costs are estimated and the effectiveness is assessed.

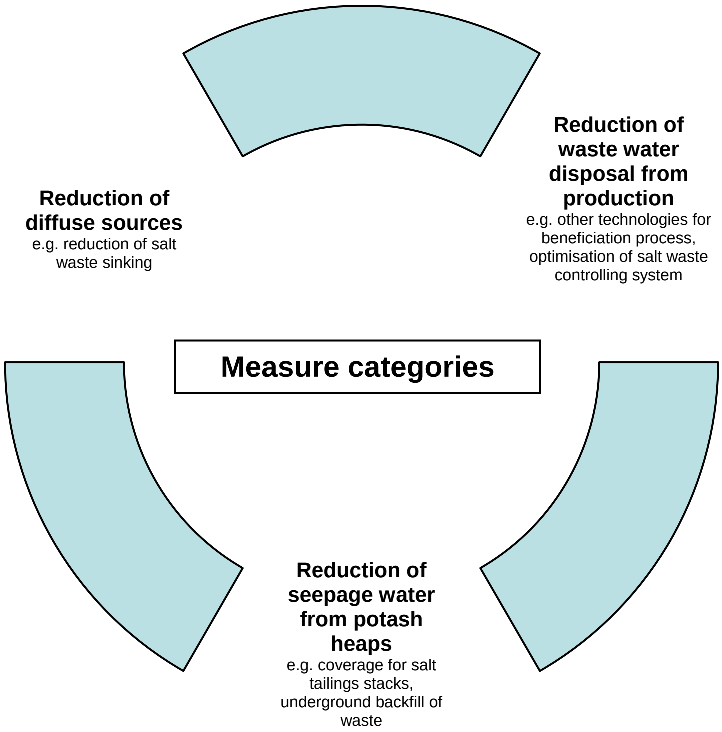

Figure 29. Measure categories to be evaluated for the reduction of salt waste.

References

Arbeitsgemeinschaft zur Reinhaltung der Weser (1996): Die Chloridproblematik an Werra und Weser, 26 S., Hildesheim.

Arbeitsgemeinschaft zur Reinhaltung der Weser (2000): Folgen der Salzbelastung in Werra und Weser für die Fließgewässer als Ökosystem, 40 S., Hildesheim.

Deutscher Verband für Wasserwirtschaft und Kulturbau e.V. (DVWK) (1993): Salz in Werra und Weser – Ursachen, Folgen, Abhilfe, in Mitteilungen des DVWK, H. 24, 188 S.

Henneberg, S. C. (1999): Lösung der Salzproblematik an Werra und Weser in Sicht?, in Wasser&Boden, 51. Jhg., H. 11, S. 30-33.

Thüringer Ministerium für Landwirtschaft, Naturschutz und Umwelt (1994): Diffuse Einträge von Salzwasser in die Werra, 16 S.

Tjaden (1915): Die Kaliindustrie und ihre Abwässer, 365 S., Berlin.

III.5.6. Harju PRB: Cost-effectiveness analysis in the Harju rivers basin

III.5.6.1. Introduction

Measures have two sides: the economic character and the technical character. The economical side takes the financial costs of measures as a starting point and uses economic and financial techniques to calculate what the most useful measures are, from an economic standpoint. On the other hand, however, it is technical: effects of the measures identified are the other important half. In this context, it is important to keep in mind that effects are strictly related to water quality.

III.5.6.2. Method and steps

Considering the costs of the measures (both investment and operational costs, i.e. those costs needed to keep the investment going in the many years to come in order to safeguard the sustainability of the expected effects) and their projected effects and trying to organise them into a ranking, starting from the most cost-effective measure and ending with the least. In this context, it is important to determine the geographical level at which ranking will be performed. It should be kept in mind that ranking should enable the selection of the most suitable alternative for a certain problem. This means that for problems at water body level (i.e. local pressures), alternative options at this specific level should be considered, in other words: ranking should ideally be done at water body level. However, the Harju river-basin sub-district has a few specific circumstances due to which a ranking at water body level is less suitable: there are relatively few local measures for water bodies at risk. The measures identified are aimed at different water bodies, which make the comparison of their effects less useful. The same problem – although to a more limited extent – still exists at sub-region level. In addition, a comparison between local and generic measures is not possible at water body or sub-region level. Therefore, the most appropriate level for ranking seems to be the Harju river-basin sub-district.

An important aspect in this is timing: if effects appear later, they are worth less than if they appear right away. If costs are made later, they weigh less heavily on budgets than if they are made now. This is expressed in using a "discount factor". In the standard scenario, we will use 5% to deflate both costs and effects. As a result, it is necessary to identify when investments will be made and when they lead to effects, i.e. right away or with some time lag. This is why the programme of measures indicates when investments are or should be made and when effects are likely to occur. This figure shows the basis for the calculations on cost-effectiveness. This table is produced for each of the local and generic measures. Both costs (both investment and operational costs) and effects are estimated for a period of 30 years[9]. Information on investment costs is taken from overviews presented by municipalities in the Harju river basin sub-region. Operating costs, which - contrary to the investment costs - are permanent, have been estimated.

	2005	2006	2007	2008	2009	...	...	2035
A. Investments (in mln €)								
Activity								
Activity								
Investment costs	0	0	0	0	0	0	0	0
B. Operating costs-effects								
Maintenance								
Other operational costs								
Total operating costs	0	0	0	0	0	0	0	0
Effect N								
Effect P-Gen								
Effect P-LF								
Total operating effect	0	0	0	0	0	0	0	0
Net operating effect	0	0	0	0	0	0	0	0
E. Internal Rate of Return INV	5%							
Revenues								
Total operating costs								
Total investment costs								
Total expenditures								
Net Cash Flow								
NPV INV								
IRR INV								

In ideal circumstances, it would be possible to express the effects in monetary terms (i.e. in kroon). However, in this framework, the key decision factor is the quality of ground-, surface and coastal water. Expressing effects of measures on the quality of water would require making a very large number of – sometimes quite uncertain – assumptions about the users of water and the value to these users of improved water quality. What is more, the many different users of water might value these effects differently, which would further complicate

9 The average time horizon for water-related investment projects, according to DG REGIO, is 29.1 years. We will therefore work with a 30-year calculation period.

expressing effects in terms of money. In addition, it will be difficult to distinguish between the different types of effects on water quality (decreased concentrations for N (nitrogen), P-Gen (phosphorus-general) and P-LF (low flow) and reflect this in monetary terms. For this reason, we have chosen to express the effects of measures in the share of excess concentrations (in %) of N, P-Gen and P-LF in the water bodies at risk. We do not value one of the three higher than others: total effects are calculated as the average of the effects of the three types of concentration (i.e. with equal weights of 1/3).

The next step is to subtract the annual costs from the estimated effects (in %) to obtain the so-called "net operating effect". Of course, the *absolute* value of this number does not bear any significance[10], but if the same calculation methods are applied to all measures alike, the *relative* values are useful for the purposes of the Cost-Effectiveness Analysis (CEA). Especially for the measures that address the same water-body, the calculations still allow their ranking on the basis of a comparison of costs and effects.

The key variables in a CEA are the Net Present Value (NPV) and Internal Rate of Return (IRR). The NPV is the sum of all net operating effects (for each year), corrected by the discount rate.

$$NPV = \Sigma_n\, (effect(n) - costs(n)) / (1+dr)^n$$

In this formula, dr stands for discount rate and n is the indicator for the years in which costs and effects are to be expressed.

The higher the *NPV*, the more cost-effective a measure is. However, this value is biased towards larger measures. In order to take this into account, we calculate the IRR, which indicates the relative "productivity" of a measure. Normally a measure of how well an investment pays off, this can be interpreted as the relative value for money of a measure: the higher the *IRR* (in %) of a measure, the better it solves the problems of water bodies per kroon invested. The IRR is calculated by analysing at which discount rate the NPV would be zero. Theoretically, it is possible that this requires a discount rate smaller than the standard (5%) – i.e. when the NPV is negative – or even a negative discount rate. Roughly speaking: the NPV indicates how much of the problems encountered the measure solves; the IRR indicates how efficiently the measure does this.

A final step in this CEA is a sensitivity analysis on the influence of a number of uncertain factors on the outcomes, i.e. the ranking of the measures. Those factors are: the discount rate (if this is increased to 10%, does this change the ranking?) and timing (i.e. if the investments are postponed to the latest moment possible instead of – as assumed in the standard scenario – executed at the earliest moment feasible).

III.5.6.3. General assumptions

In every CEA, it is important to communicate clearly on the basis of which assumptions the analysis has been made. In this case, we have used the following assumptions:

✓ We assume that the value of an effect is based on the share of the needed reduction solved by the measure (i.e. not the absolute value). This value is independent from the size of the water-body or its location. As a result, the effects cannot be translated into money-terms. Instead, the unit of calculation will be % / EEK, indicating the relative reduction of excess concentrations (average over the 3 main types[11]) in a water-body per hundred thousand kroon[12]. All effects are assumed to take place within one year of the finalisation of the measure. In the calculations, the effects in the first year after the measure are only incorporated for half of their value as they come into being during the year.

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10 By choosing to present the effects in pro-mille instead of percentages improvement, these numbers would be 10 times higher, with direct consequences for the net operating effect. This is the direct result of the fact that the dimensions of costs and effects (Kroon and %) are not compatible.

11 N, P-Gen and P-LF. We will weight these effects equally, i.e. N counting for 100% while P-Gen and P-LF (as 2 different ways of measuring P-effects) both count for 50%.

12 This unit value was chosen in order to avoid negative net operating effects in all years of the analysis for some of the projects, which would make it impossible to calculate an IRR for these projects, in its turn making comparison with other measures more difficult.

✓ If a measure in a plan sent by municipality was mentioned for a year before 2005, we assume this was planned earlier but has not been carried out yet and will be implemented in the order of planning, starting from the year 2005.

✓ On the operational costs, we assumed a value of 2,5% of the investment costs per year and that this will be available from municipal budgets in the future.

✓ If a measure achieves a reduction in the concentration of one of the types (N or P) but for this specific type, no reduction is needed (because the concentration is already within the norm); the effect in this particular CEA will be considered to be zero. If the reduction is larger than needed, the effect will be considered to be 100% for this type.

✓ The measures taken into account and their costs (incl. time frame) from the municipal investment plans. If it is not known in which year the investments are planned to take place, a first allocation is made on technical grounds. If this does not lead to a clear answer, an allocation on economic grounds will be made. In respect to the latter, we distinguish between two different approaches:

✓ Investment right away (as-soon-as-feasible or ASAF approach) in order to achieve the beneficial effects for inhabitants and economic activity sooner rather than later.

✓ Investment at the end (as-late-as-possible or ALAP approach) in order to economise on budgets and make costs as low as possible for all measures (due to moving them to the future)

✓ The basic discount rate has been set at 5%, in the following sensitivity analysis, we have used 10% as well.

✓ Assumed is that if effects appear, they will remain constant over time in the future and that they will be permanent.

✓ Whenever the effect of a measure is expected to appear within one year of the investment being made, we assume that the size of this effect will only be half of the expected value during the first year after the investment.

✓ The average time horizon for water-related investment projects, according to DG REGIO, is 29.1 years. It would be reasonable to work with a 30-year calculation period. However, since the particular circumstance of the Water Framework Directive makes effects after 2015 much less valuable, the analysis below is based on a comparison of costs and effects for the coming 10 years (i.e. up until 2015).

III.5.7. Suldal PRB: Cost-effectiveness analysis in the Suldal rivers basin

III.5.7.1. Did you develop a methodology?

Norway has not yet established a specific methodology for CEA related to the WFD, but will do so in 2006 - 07. However, there is a relatively long tradition for CEAs in Norway and a national methodology has been used since the mid 1990s. This methodology is based on quality criteria related to different user purposes like drinking water, bathing water, etc. The new methodology will be built on our existing methodology and practices on planning and prioritizing abating measures. In the ongoing preparatory work, elements from the German handbook on cost effectiveness analysis are being assessed.

III.5.7.2. Do you have data on costs, measures, effectiveness, benefits

In 2003, a review of the experiences on CEAs in Norway was made as a part of the preparatory work for implementing the WFD. This project showed that quite a few CEA and CBA have been undertaken in Norway, but the analyses have been carried out in different ways and based on different assumptions. Most analyses were related to environmental problems concerning N and P (eutrophication). Based on only historical, national data it will not be possible to make standardized estimates on cost effectiveness that apply for most common measures.

III.5.7.3. Are you currently testing the methodology?

A national guideline on programmes of measures will be developed in 2006. This guideline will also include CEA and will need to be tested on real cases before final approval by national authorities. The methodology is believed to be refinished in the second planning cycle. Some part of the testing on the national guideline might be done in the Suldal pilot river basin (autumn 2006).

An ongoing project on measures in regulated river basins will provide a summary on commonly used measures, their purposes, their costs and effects. This project will be finished in April 2006 and will be reported through the Suldal PRB and the new CIS working group on hydromorphological changes (HyMo).

Another project concerning regulated rivers and lakes will develop a methodology to set the environmental objectives for heavily modified water bodies. This methodology will use effects of potential measures as the starting point and procedures to estimate costs as well as environmental effects will be studied. This project will also analyze when "ecological potential" is the environmental objective or if it necessary to apply for exemptions according to "disproportionate costs" of implementing the potential measures.

III.5.7.4. Which issues are the most important for you? What do you do to address them?

Effectiveness of measures:

The largest challenges are believed to be related to the effects of measures on the ecological parameters and the ecological status. Qualitative, quantitative and semi-quantitative estimates need to be handled together somehow. Another challenge is related to how to deal with side effects in a multi target analysis.

Effects of measures to decrease phosphorus (P) have been given most attention related to CEA in Norway and other European countries. Effects of mitigating measures applied to reduce damages caused by encroachments like hydropower regulation have been given much less attention. The new methodology needs to be applicable to all kinds of water problems and corresponding mitigation measures. This implicates that the methodology needs to be simple, maybe even more simple than the already existing methodology on phosphorus.

CEA in the planning process:

CEA should be dealt with at the lowest level that is possible and appropriate. The management plan will be at the regional level (river basin district level). The harmonisation between local CEAs and the regional management plan and existing sector programmes of measures will be more carefully considered in 2006.

There is a challenge on how to deal with the trade-off between cost-effectiveness and political acceptance. Another issue is when to involve who. The general approach will most likely be to involve all relevant stakeholders as early as possible. But the technical part of a CEA (like estimating cost and effects) will need to be as unpolitical and unbiased as possible to have an indisputable document as basis for further work on how to prioritise and finance measures.

Scale:

The scale issues are not considered to be a huge challenge since CEA will be carried out at the same level as the extent of the specific water problem. In other word, CEA will be carried out at different levels depending on the problem that needs to be dealt with. The challenge will appear when several CEAs must be added together in the POMs.

Uncertainty:

The review project from 2003 showed that the analyses must be made quite simple, bearing in mind that the River Basin Authorities and the local municipalities are small and have limited capacity to carry out analyses. The methodology must be first understood and then used. Often there will be a trade-off between what is theoretically correct and practically feasible. We want to make that trade-off as little as possible.

III.5.8. Conclusions and recommendations

The presented CEAs show approaches of PRBs describing the steps of the methodology. PRB Odense uses data on effectiveness and unit costs of measures to analyse the economic and environmental consequences of alternative scenarios aiming at nitrogen reduction. Socio economic costs are taken into account.

PRB Jucar demonstrates the use of water quantity and quality river basin simulation models in the process of CEA. The development of these models allows a realistic quantification of the effectiveness of different (set of) measures dealing with water quantity/quality issues in the basin, considering the interconnection among the water bodies. The use of a generalized Decision Support System facilitates the development of these models. Considering water scarcity conditions, the opportunity cost of meeting the environmental constraints (e.g., minimum streamflow requirements) can be assessed by the use of a hydro-economic model in which we represent the economic value of water for the different competing uses. The most cost-efficient combination of alternatives can be determined through the iterative simulation of different set of measures or by an optimization procedure.

Long term industrial salt pressures from potash mining in the Weser PRB have lead to a constant point and diffuse input of chloride. Measures to improve the salt pressure have been introduced since the 1990’s but the good ecological status will not be achieved during any conceivable timeframe. Technical feasibility and socio-economic consequences of mitigation measures are the main issues.

About Phase II of the Pilot River Basin Activity

Since the adoption of the Water Framework Directive in 2000, a Common Implementation Strategy (CIS) was set up to guide its implementation. In a first phase a set of guidance documents were prepared, which were tested by the Pilot River basins. The outcome of this exercise is reported in the 2005 Pilot River Basin Outcome report. In the second phase – running from 2005-2006 and coinciding with the third CIS work programme - the Pilot River Basins have been involved in the different working groups and other activities set up in the CIS, and a wide variety of topics have been subject to pilot exercises. More information can be found on the European Commission's Directorate-General for the Environment Website:

http://ec.europa.eu/environment/water/index.html

III.6. LINK WITH RESEARCH

This report was prepared by the Pilot River Basins ***Gascogne*** *(FR). More information about this river basin can be found in chapter II or at: http://ec.europa.eu/environment/water/water-framework/prbs.htm. The report addresses (one) specific aspect(s) of the common implementation strategy for the Water Framework Directive (Directive 2000/60/EC), as part of the second phase of a pilot basin river activity.*

III.6.1. Introduction

To reach the goal of contributing to the provision of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use, and to a significant reduction of pollution in groundwater, it's clearly specify, in article 20 of European Water Framework Directive (WFD), since it is a long planned process (over a minimum of 15 years), that scientific and technical progress has to be integrated within the implementation of the WFD.

The 6th Environmental Action Programme stipulates that "sound scientific knowledge and economic assessments, reliable and up to date environmental data and information, and the use of indicators will underpin the drawing –up of implementation and evaluation of environmental policy."[13]

Relevant requirements of the Water Framework Directive

The WFD gives some indications where and when, in the implementation process, its is necessary to integrate new scientific and technical knowledge (economic analysis, standards for monitoring of quality elements, review and updating of river basin management plans, identifying priority hazardous substances, …).

Article 16 on Strategies on pollution of water does for instance lay down the requirements for a scientifically based risk assessments and consultation of relevant scientific advisory bodies, in the process of identifying priority substances.

This question of the integration of scientific knowledge into professional sectors and public policies has been considered differently within the 40 last years. During the sixties and seventies it was generally believed that useful results for industry and society would start flowing from basic research according to a so-called linear model of innovation (in Erno-Kjolhede 2001). During the eighties and nineties, it was the period of moving process from the science push doctrine, corresponding to the self-governing science, to society pull science. Therefore, the research became governed by the need to respond to the problems confronting the societies and economies (in European Commission, 1997, un-paginated preface).

One think is to require society-pull-science, another is to organize an efficient production of knowledge that can support environmental policies, since it is the goal of this article. Gibbons et al. (1994) has described, in an influential book entitled "The new production of knowledge", the development from the dominant "traditional" mode of production of knowledge (so-called Mode 1) to a much more complex and heterogeneous mode of knowledge production (so-called Mode 2). In Mode 1, knowledge is mainly created and communicated within academic institutions and within domains of specialized scientific disciplines. Mode 2, which is supplementing, not supplanting, Mode 1, is a response to the more and more complex problems of modern society and notably to the question of water that is linked to almost most of the human activities and organizations. Mode 2 is said to be "transdiciplinary", since it mobilizes several scientific disciplines not only from universities. Quality in Mode 2 is not only linked to intellectual dimensions but also to social, political and economic support, but it still

[13] Decision No 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme [*OJ L 242, 10.9.2002, p. 1–15]*

takes place in a scientific arena. In the last nineties, it became important to make industry, public policy and research to co-operate sufficiently. It was that Etzkowtiz and Leydesdorf (1997, 1998) called a "triple helix" of science policy. This is a metaphor that illustrates the fact that there are permanent interactions between these partners and that the development of each partner can be described as a spiral, since the global approach is based on networks and iterative process.

Considering water policies, if a global approach is indispensable (at the EU level or at national level), local specificity (River Basin District scale) have to be taken into account. Therefore scientific support to water policies implement has to be considered at the two levels[14].

Here we address the River Basin District (RBD) scale and the associated sub-territories. The Gascogne Rivers PRB is one of the so-called "hydrographic unit of reference (UHR)" of the Adour-Garonne RBD.

III.6.2. Gascogne PRB: testing a new methodology in the Gascogne Rivers PRB Case.

At the Adour-Garonne RBD scale, we have been experimented the "triple helix" method for 10 years through the science-society-policy interface called ECOBAG (for environment, ecology and economy of the Adour-Garonne RBD). To propose innovative approach in the implementation of water policies, such has the WFD, it is necessary to create the interactions that will produce the triple helix dynamics. The ECOBAG methodology is based on several steps. The first step is to identify the major issues within the RBD for which water "actors" meet problems to implement the corresponding policies. The second step is to organise an iterative and collaborative process of co-identification of problems that require scientific support to be solve. This process is at the early beginning involving representatives of decisions makers, water managers, water users, related water enterprises and scientists. This process allows 1 /rewording problems for water management or policy implementation into scientific questions, and 2 / identifying the kind of scientific answer (transfer, multidisciplinary expertise, demonstration, research-development, or research projects). The third step is to build up the corresponding projects in the same collaborative approach.

Within the Gascogne Rivers PRB, we have applied this method to tackle the questions related to agriculture and WFD implement. The result of the triple helix approach is the demonstration project "Concert'Eau".

III.6.2.1. Concert'Eau: an operational link with research

This PRB has a size of 6800 km² (6 % of the District), with a population of 263 000 inhabitants (4% of the District's permanent population, INSEE 1999). According to the local basins, 60 to 80% of the total acreage is used for agriculture with crops such as maize, wheat, sunflower, soy bean… and breeding (ducks, cattle…). In this PRB, nitrate and pesticides are found in surface waters. (Refer to Presentation of Gascogne Rivers PRB for more details).

Following the WFD objectives, river basin management plans including summaries of programs of measures should be drawn up to reach the main goal of the "good status" of all waters (Article 4, Article 13 and Annex VII (6) (7)). The programs of measures can be considered as one of the major mechanisms for the implementation of the environmental objectives of the WFD.

The WFD distinguishes between basic measures (minimum requirements) (Article 10 WFD), and supplementary measures. Basic measures include, according to Annex VI (Part A), the implementation of a number of environmental directives (e.g. Nitrates Directive (91/676/EEC)) that directly or indirectly assist in the protection of water. If the basic measures are not sufficient, supplementary measures should be applied (non-exclusive list of such measures in Annex VI Part B WFD) including measures such as economic and fiscal instruments, negotiated environmental agreements, codes of good practice, voluntary agreements, demand management measures, efficiency and re-use measures, rehabilitation

[14] See also paper "Science-policy integration needs in support of the implementation of the EU Water Framework Directive" (Environmental Science & Policy, 8 (2005) p 203-211)

projects and research, and development and demonstration projects.

By referring to this point and to the works that have been conducted by the GRAMIP (Regional Group for Actions on Pesticides in Midi-Pyrénées Region) for 5 years, it came out that basic measures which have been tested, had failed to be applied at large scale. For example, GRAMIP has been supported 4 experimental small agricultural watersheds (from 100 to 1000 ha) to implement agro-environmental measures (AEM). These experiments highlight the difficulties to scaling-up to larger agricultural zones the AEM. Studies have demonstrated the importance of socio-economic dimensions in the process of co-operation and willingness of farmers to participate to the implementation of water protection projects.

Therefore, with Concert'eau, we propose a collaborative technological platform (CTP), gathering scientists from large range of disciplines, decision makers, water managers and, cooperatives and agriculture organizations, that will be developed to support an integrative management of agriculture that matches WFD objectives in compliance with the Common Agriculture Policy (CAP) and national and local policies. This CTP will deliver mitigation measures (MM) and a program of actions (PoA) to mitigate impacts of agriculture activity on water resource and associated aquatic ecosystems of the Gascogne Rivers PRB.

The innovation of CTP is to propose possible MM in a collaborative process, to simulate and to evaluate these MM.

The CTP will combine 1 /working groups of actors gathering administrative officials, scientists, political and citizen leaders, cooperatives and agriculture organizations that will produce different MM of relevant actions focusing on agriculture and environment management in order to improve water quality by considering the viability of proposed MM for farming enterprises, 2 / a high-technology toolbox to simulate and evaluate the proposed MM. The toolbox will make possible to run expertise, database, simulators and GIS through a web collaborative management system, 3 / multidisciplinary expertise of the proposed and simulated MM.

About Phase II of the Pilot River Basin Activity

Since the adoption of the Water Framework Directive in 2000, a Common Implementation Strategy (CIS) was set up to guide its implementation. In a first phase a set of guidance documents were prepared, which were tested by the Pilot River basins. The outcome of this exercise is reported in the 2005 Pilot River Basin Outcome report. In the second phase – running from 2005-2006 and coinciding with the third CIS work programme - the Pilot River Basins have been involved in the different working groups and other activities set up in the CIS, and a wide variety of topics have been subject to pilot exercises. More information can be found on the European Commission's Directorate-General for the Environment Website:

http://ec.europa.eu/environment/water/index.html

III.7. PRIORITY SUBSTANCES AND OTHER POLLUTANTS

This report was prepared by the Pilot River Basin ***Odense*** *(DK)). More information about this river basin can be found in chapter II or at: http://ec.europa.eu/environment/water/water-framework/prbs.htm. The report addresses (one) specific aspect(s) of the common implementation strategy for the Water Framework Directive (Directive 2000/60/EC), as part of the second phase of a pilot basin river activity.*

III.7.1. Introduction to the Water Framework Directive and priority substances

Relevant requirements of the Water Framework Directive

The Water Framework Directive stipulates the implementation of measures for a progressive reduction of discharges, emissions and losses of a group of priority substances and the cessation or phasing-out of discharges, emissions and losses of priority hazardous substances. The time frame for attainment of this objective is 20 years after the adoption of the specific legislation required by article 16(8). A "daughter directive" shall establish environmental quality standards for each priority substance, which are the standards to be met in order to comply with the definition of "good chemical status":

The Water Framework Directive (WFD) identifies a number of substances – 33 at present – as priority substances from amongst those that present a significant risk to or via the aquatic environment.

The priority substances identified also include substances designated as priority hazardous substances.

Pursuant to the WFD the European Parliament is required to adopt measures aimed at the progressive reduction of discharges, emissions and losses of all priority substances and the cessation or phasing-out of discharges, emissions and losses of priority hazardous substances. The time frame for attainment of this objective is 2025.

In addition, the WFD requires the Commission to draw up proposals of controls for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of priority hazardous substances, and to draw up proposals for environmental quality standards for the substances.

III.7.1.1. Proposal for a new directive

On 17 July 2006 the Commission adopted a proposal for a new directive setting environmental quality standards for priority substances and amending the WFD. The proposal implements the WFD provisions on the establishment of environmental quality standards. The proposed new directive revises the WFD list of priority substances (Annex X). Of the 33 substances that continue to be listed as priority substances, 13 are identified as priority hazardous substances. The substances are listed in Annex I and II. The proposed directive leaves it to Member States to identify the most appropriate combination of pollution-limiting measures to ensure compliance with the WFD objectives for priority substances and priority hazardous substances. At the same time the directive leaves it to Member States to establish the necessary emission controls by incorporating them into the programme of measures to be drawn up for each water body.

III.7.1.2. The directive's environmental quality standards

The proposed new directive establishes two types of environmental quality standard for each priority substance – the annual average concentration and the maximum allowable concentration. These environmental quality standards have to be met at minimum in order to comply with the WFD definition of "Good status".

The quality standards solely apply to surface water, it being considered that the limit values for surface water will generally also safeguard biota and sediments. With three substances, however, specific quality standards have also been set for biota. Member States are required to set quality standards for biota and sediment in cases where it is considered that the general quality standards for surface water will not provide sufficient protection.

Quality standards for pollutants not designated as priority substances – primarily those listed in WFD Annex VIII – are to be set nationally where necessary.

The proposed directive allows Member States to designate a transitional area for each relevant point of discharge where the relevant environmental quality standards may be exceeded. This applies to both the environmental quality standards stipulated in the directive and those set nationally.

III.7.1.3. Monitoring

Member States are required to establish an inventory of discharges, emissions and losses of all priority substances and pollutants listed in the directive for each river basin.

The frequency of monitoring is specified in WFD Annex V Section 1.3.4. Thus for surveillance monitoring a minimum of 12 samples a year are required for the priority substances and a minimum of 4 samples a year for other pollutants, cf. WFD Annex VIII. The same frequency is recommended for operational monitoring.

Box 1
In this report the term hazardous substances is used to denote both heavy metals and organic micropollutants (substances that do not occur naturally in the environment) including PAHs.

III.7.2. Odense PRB: Chemical pollution management in the Odense River Basin

III.7.2.1. Introduction

In Denmark, pressure from hazardous substances is mainly regulated via the Statutory Order No. 921/1996 on quality standards for water bodies and emission standards for discharges of certain hazardous substances to watercourses, lakes or the sea. This statutory order requires that discharges of hazardous substances be reduced as much as possible with the aid of the best available technology.

The statutory order stipulates quality standards regarding the aquatic environment for a large number of substances. The statutory order is primarily applicable to discharges of the substances in question. Thus the conditions stipulated in discharge permits must be such that following initial dilution, the discharge in question will not lead to exceedance of the quality standards by the recipient water body.

Thus the nationally applicable Danish water quality standards have primarily been used to regulate discharges of the substances in question. The quality standards have not been used to assess compliance with the environmental objectives for water bodies.

No regulations pertaining to hazardous substances have yet been implemented in Denmark regarding monitoring frequency and control calculations in relation to the water quality standards – regulations that are now contained in the WFD.

The quality standards stipulated in the statutory order are regularly revised via an Internet database run by the Danish Environmental Protection Agency.

The statutory order encompasses the substances identified by the European Commission as priority hazardous substances. Not all priority substances are yet encompassed by the statutory order, however. The statutory order is currently being revised.

The present case describes hazardous substance loading from sources in the catchment of Odense Fjord and the environmental status of the watercourses, lakes, groundwater and marine waters. Compliance with the environmental objectives for these water bodies is also described. In connection with monitoring and other investigations of sources and recipient waters, Fyn County has measured the concentration of a large number of hazardous substances, including the substances included on the list of priority substances and priority hazardous substances (Annex I). The present section describes all the relevant hazardous substances measured, however. The results have been evaluated using Danish quality standards and international quality standards (e.g. the OSPAR Convention) set on the basis of effect studies.

Substance/groups of substances	Stige Ø waste depository, percolate	Harbour sludge depository	Wastewater treatment plants	Industry, wastewater	Industry, air-emission	Sediment in harbours	Depository, Lindø	Contaminated land	Groundwater remedial boreholes	Groundwater	River Odense	Odense Fjord	Lakes
Metals**	x	x	x	x	x	x	x	x		x	x	x	x
PAH**	x		x	x	x	x		x		x	x	x	x
PCB	x		o	x		x						x	x
DDT								-			o	x	o
TBT (organotin)**		x				x	x					x	
Other antifouling agents*		x				o						x	
Pesticides**	x		o					x	x	x	x	x	x
LAS	x		x								x	x	x
Other detergents			x										
Phenols**	x		x	x			x	x		x	x	x	x
Chlorophenols	x		x	o						x	x	o	o
Plasticizers*	x		x							o	x	x	o
Aromatic hydrocarbons**			x	o			x	-		x	x	x	
Chloro-hydrocarbons**	x		x					x	x	x	x	x	o
MTBE (ether)			x					-	x	x			
Phosphotriesters			x									x	o
Oil-petrol-compounds	x							x		x			
Dioxin					x								
Brominated flame retardant**			-									x	x

Table 9. Inventory of the substances and groups of substances analysed for in the individual sources and recipient waters.

Key:
x: Analysed for and detected
o: Analysed for, but not detected
–: Analysed for, but not reported
* Individual members of the group are included on the list of priority substances
** Individual members of the group are included on the list of priority hazardous substances.

III.7.2.2. Monitoring of chemical pollution

In Denmark the aquatic environment is monitored nationally under the National Monitoring and Assessment Programme for the Aquatic and Terrestrial Environments (NOVANA). This also encompasses the monitoring of hazardous substances in various matrices, e.g. the water phase in lakes, watercourses and the sea, sediments and biota in the sea, and wastewater (table 9).

The monitoring encompasses a large number of substances included on the list of priority substances. New substances are first added to the program if and when screening studies indicate a need to include them.

Substances that are not detected in the aquatic environment after several years of monitoring or only detected in insignificant amounts are removed from the monitoring programme. The list has now been reduced to approx. 190 substances from the original figure of approx. 250.

The national monitoring (Hazardous substances and heavy metals in the aquatic environment; NERI, 2006) has shown that the investigated media often contain substances included on the list of priority hazardous substances. Among other things, both mercury and cadmium have been detected in wastewater, typically in concentrations below the applicable quality standards for water bodies. Nonylphenol concentrations in effluent from wastewater treatment plants are also usually below the quality standard for water bodies. In contrast, the concentrations of PAHs in stormwater discharges, etc. are often close to the applicable quality standards for water bodies.

III.7.2.3. Sources/loading conditions

Odense River Basin (the catchment area of Odense Fjord) contains a large number of sources of pollution with hazardous substances. Input of the substances takes place both from the catchment and from the air. Thus hazardous substances are input to the groundwater, lakes, watercourses and the fjord from urban and industrial wastewater treatment plants, sparsely built-up areas, stormwater outfalls, remedial boreholes, contaminated soil, waste depositories, agricultural activities in rural areas, harbour activities and shipping. Moreover, substances emitted to the atmosphere from combustion plants, transport, agriculture and industrial dust can subsequently be input to the aquatic environment via deposition (wet deposition and dry deposition).

Some of the substances undergo considerable turnover/degradation, while others can remain in the aquatic environment for a very long time.

Our knowledge of the source apportionment of hazardous substance loading of the aquatic environment is limited. Figure 30 indicates the point sources for which data on hazardous substances are available. A number of hazardous substances have been detected in all these sources (table 9). In addition, as mentioned above, a number of smaller point sources and diffuse sources such as surface runoff from arable land and air pollution may also contribute to hazardous substance loading of Odense Fjord.

The magnitude of the various sources in the catchment area of Odense Fjord has previously been assessed (Fyn County, in press), but the findings are subject to great uncertainty due partly to the fact that the magnitude of the individual sources has been assessed on the basis of a limited amount of data and partly to the fact that the data differ considerably from source to source. With some sources, moreover, no data are available at all.

The general assessment is that the hazardous substances detected in Odense Fjord largely derive from the catchment area, although some of the substances, e.g. dioxin and NMVOC largely derive from atmospheric deposition. The airborne pollution stems from local, regional and global sources. With substances such as heavy metals and PAHs, many different sources contribute to pollution of Odense Fjord. With other hazardous substances, in contrast, fewer sources are responsible.

With a few of the substances it is possible to judge the magnitude of the sources from measurements of their concentration in water and biota from the fjord together with assessment of their effects.

Investigations of intersex in common periwinkles at three stations along a gradient from a large shipyard and at two stations near a busy seaway thus show that the main source of tributyl tin (TBT) loading of the outer fjord is the shipyard, while shipping is judged to comprise a minor source in the outer fjord (figure 31). Measurements of the TBT concentration in the water in the outer fjord showed that the waste depository at the shipyard previously contributed to TBT pollution of Odense Fjord. Correspondingly, measurements of the TBT content of mussels show that the river Odense discharges TBT into the inner fjord.

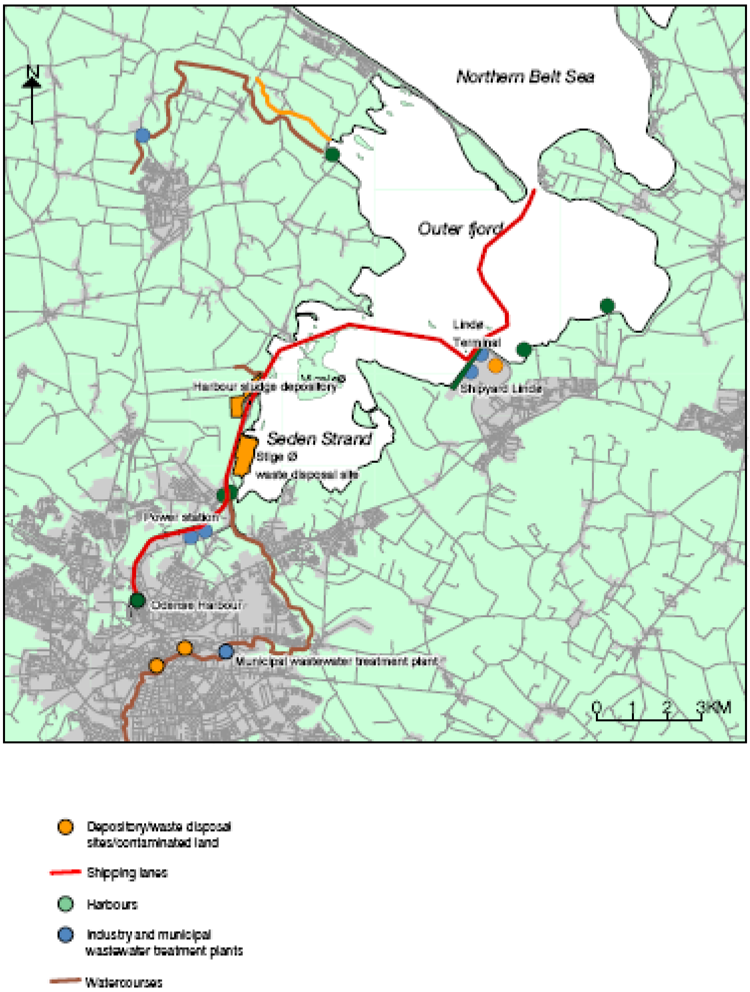

Figure 30. Map of the sources of pollution in the catchment for which data on hazardous substances are available.

Measurements on mussels collected just off the outlet of the river Odense and at a former waste depository show that PAHs are discharged from there. The copper, PCB and PAH content of mussels is higher at a station near the shipyard and near a vehicle scrap yard than at other stations in the inner fjord.

III.7.2.4. Expected trend up to 2015

With many of the sources, measures have been taken in recent years or will be taken in the coming years to reduce discharges of hazardous substances. This particularly applies to surface water and dust from vehicle scrap yards, leaching of percolate from former waste depositories, stormwater outfalls and leaching from the shipyard waste depository. Further measures include the establishment of filters for wastewater from the harbour sludge depository and the phase-out of TBT-based antifouling paints. Cessation of the use of TBT in antifouling paints will probably entail an increase in the input of other antifouling agents such as copper and SEA-NINE, however. When issuing permits for enterprises to connect to the public sewerage system, the municipal authorities are increasingly taking into account possible pollution with hazardous substances.

With many sources, however, input of hazardous substances is not expected to decrease significantly. Moreover, increased use and consumption of new substances cannot be excluded up to 2015.

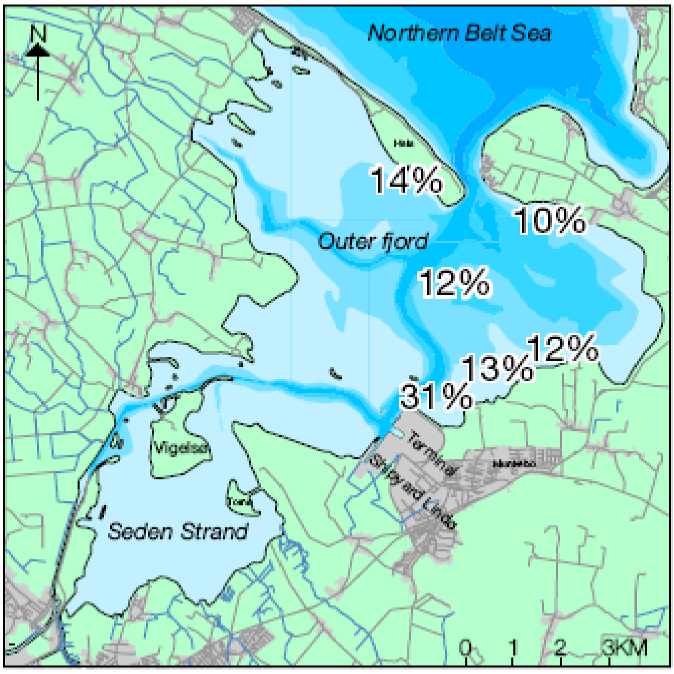

Figure 31. Intersex in female common periwinkles (Littorina littorea) at six stations in Odense Fjord expressed as percentage intersex frequency in 2005. Intersex is a sexual disturbance in marine mollusks caused by the effects of TBT.

III.7.2.5. Environmental status and compliance with environmental objectives

Watercourses, Status: Over the period 1990–2004, between 144 and 494 Mm^3 fresh water flowed into Odense Fjord from the river basin each year. The largest watercourse in the river basin, the river Odense, drains approx. 60% of the catchment.

In general, little information is available about the concentration of hazardous substances in the watercourses. Thus the river Odense is the only watercourse in which the concentration of hazardous substances has been regularly monitored (table 9). The investigations have been performed since 1994, mainly at a station near the river's outlet and upstream of a major wastewater treatment plant (Ejby Mill WWTP). In addition, heavy metals have been measured at a station at Nr. Broby (early in the course of the river), and pesticides have been measured at a station upstream of the city of Odense (Kratholm).

A large number of different pesticides have been detected in water samples from the river Odense (see figure 32). Fully 40% of the just under 100 substances analysed for were detected with varying frequency and in concentrations of up to 11 µg/l. The majority were herbicides, as is to be expected as this group of substances contains the greatest number of pesticides in use. Pesticides or pesticide degradation products have also been detected in sediment samples from the river Odense, including pyrethoids.

The substances detected in the water samples occur in relatively low concentrations. Herbicide damage to the aquatic plants is therefore unlikely (Cedergreen et al., 2004). In contrast, a number of insecticides (the pyrethoids) that are rather insoluble in water and typically occur in such low concentrations in water as to be undetectable using normal methods may pose great problems to stream macroinvertebrates. These substances – which were not detected in the above-mentioned water samples, though – easily bind to sediment and have been detected in sediment samples. New Danish investigations (Møhlenberg et al., 2004; Lauridsen and Friberg, 2005; Nørum et al., 2006) also show that pyrethoids in concentrations as low as 1 ng/l markedly affect behaviour and reproduction in macroinvertebrates. In a number of cases the presence of these substances in watercourses on Fyn has been shown to cause high mortality among insects and crustaceans in particular, and sometimes among fish (see for example Wiberg-Larsen et al., 1991). Over a 10-year period, pyrethoids are considered to have caused considerable damage to the macroinvertebrate fauna in some watercourses. The pesticides primarily derive from runoff from filling and washing stations used for agricultural spraying equipment, runoff from market gardens, leaching from fields (both surface runoff and via field drains), and to some extent via wastewater discharges. From the environmental point of view the first two sources are undoubtedly the most important. Pesticide loading seems to have decreased considerably in recent years, however.

At the station at Ejby Mill WWTP, many different hazardous substances have been detected (see figure 33). Some of these occur in concentrations exceeding the national quality standards, although the concentrations are not alarmingly high.

The concentration of heavy metals has been investigated in water from the river Odense near Nr. Broby. With cadmium and mercury, the concentration did not exceed the applicable quality standards for fresh water (5.0 and 1.0 µg/L, respectively). With the other metals such as arsenic, lead, chromium, copper, nickel and zinc, the quality standards vary between 3.2 µg/L and 160 µg/L. Concentrations exceeding the quality standards (4 µg/L and 3.2 µg/L, respectively) have only been detected in a couple of cases for arsenic and lead. Heavy metals have also been measured in the river Odense at Ejby Mill WWTP. The concentrations detected are unlikely to have any negative effects on either aquatic plants or animals.

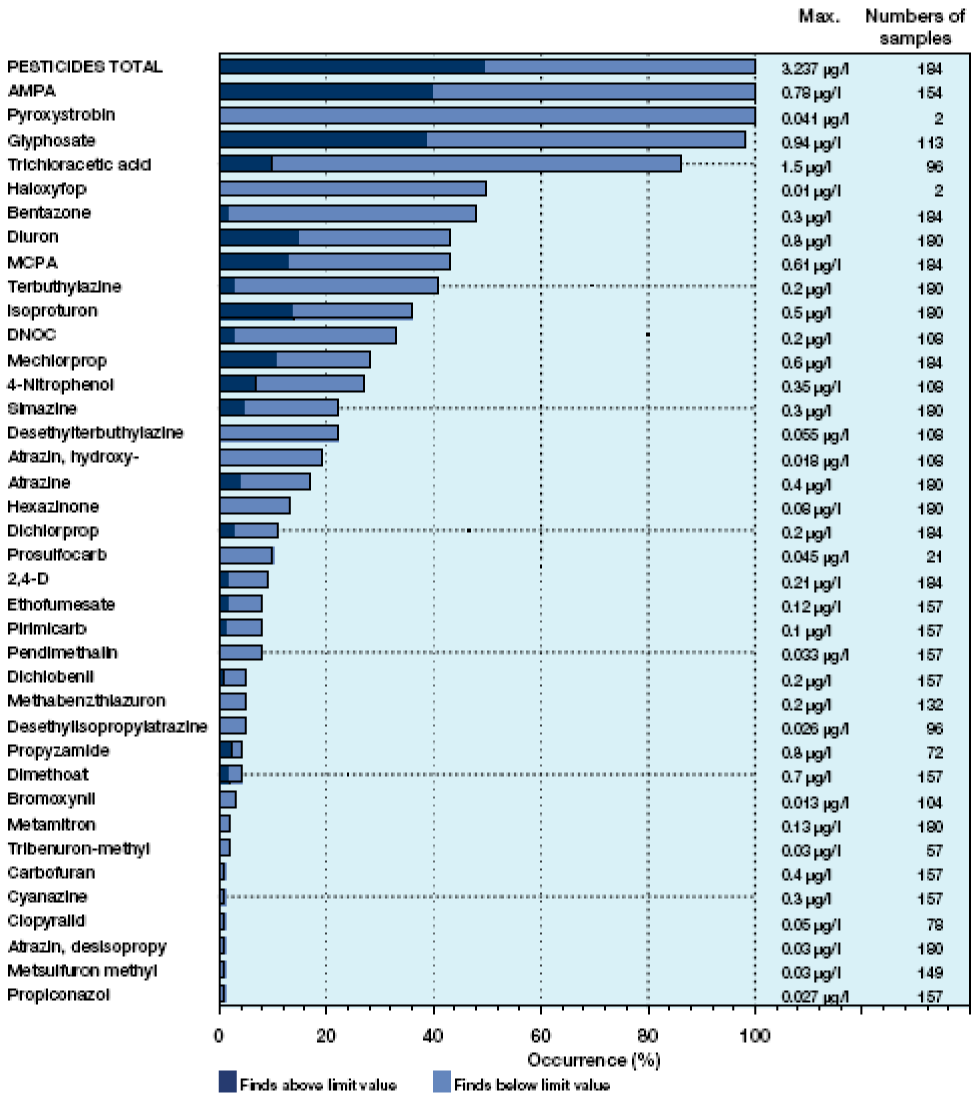

Figure 32. Pesticides detected in water samples from a station upstream of the city of Odense (Kratholm). Many other pesticides were analysed for, but not detected. For each substance the table shows the number of samples collected, the highest measured concentration and an indication of whether the concentration is above or below the limit value for drinking water (0.1 µg/L).

Many hazardous substances bind to the watercourse sediment and accumulate in it. This has been investigated in the river Odense at four stations spaced along the reach running through the city of Odense. From figure 34 it is apparent that the hazardous substance content of the river sediment increases down through the city in line with the increasing loading from storm-water outfalls. There were no significant differences between samples collected immediately after precipitation and those collected after dry periods.

The concentrations of lead and PAH at stations B3 and B4 (figure 30) were higher than those in sewage sludge from a major wastewater treatment plant in the city of Odense, and thus should be considered to be extremely high.

The biological effects of hazardous substance loading are unclear, and at the same time are often difficult to distinguish from the effects of organic matter, ammonia and physical conditions. Fyn County has investigated the ability of the caddis fly *Hydropsyche siltalai* to spin the elaborate net that it uses to catch its food at four stations in the river Odense where it runs through the city of Odense. The investigations do not indicate that the discharged hazardous substances have had any major effect on the behaviour of this caddis fly (see Wiberg-Larsen, 2004). The possibility cannot be excluded, though, that the substances may affect other macroinvertebrates, for example those inhabiting the sediment.

A number of hazardous substances cause endocrine disruption in fish, etc. These substances also occur in watercourses on Fyn, and investigations in other Danish and foreign watercourses have shown marked changes in fish reproduction that could be attributable to the substances' endocrine disrupting properties. New studies provide no indication that the problem is particularly extensive in Odense River Basin, however (Larsen, 2005).

Compliance with environmental objectives: At the station upstream of Ejby Mill WWTP, water samples are collected 12 times each year for analysis of eight heavy metals and 112 organic micropollutants. Comparison of the maximum annual mean concentration at this station with the applicable quality standards (Danish Ministry of Environment and Energy, 1996) shows that the content of several of the substances exceeded their quality standard (table 10).

In view of these findings it is concluded that the river Odense does not meet the environmental objectives. As sufficient analysis results are only available for this one station (Ejby Mill WWTP), it will presumably be necessary to expand the watercourse monitoring programme in order to be able to assess compliance with the environmental objectives in future.

Lakes, status: the concentration of hazardous substances has only been investigated in the water phase of one lake in Odense River Basin – lake Arreskov. The investigations encompassed seven heavy metals (in 1998 and 2001) and 47 pesticides and 24 other organic micropollutants (in 2001 and 2003).

The heavy metals concentrations were considerably below the quality standards for surface waters.

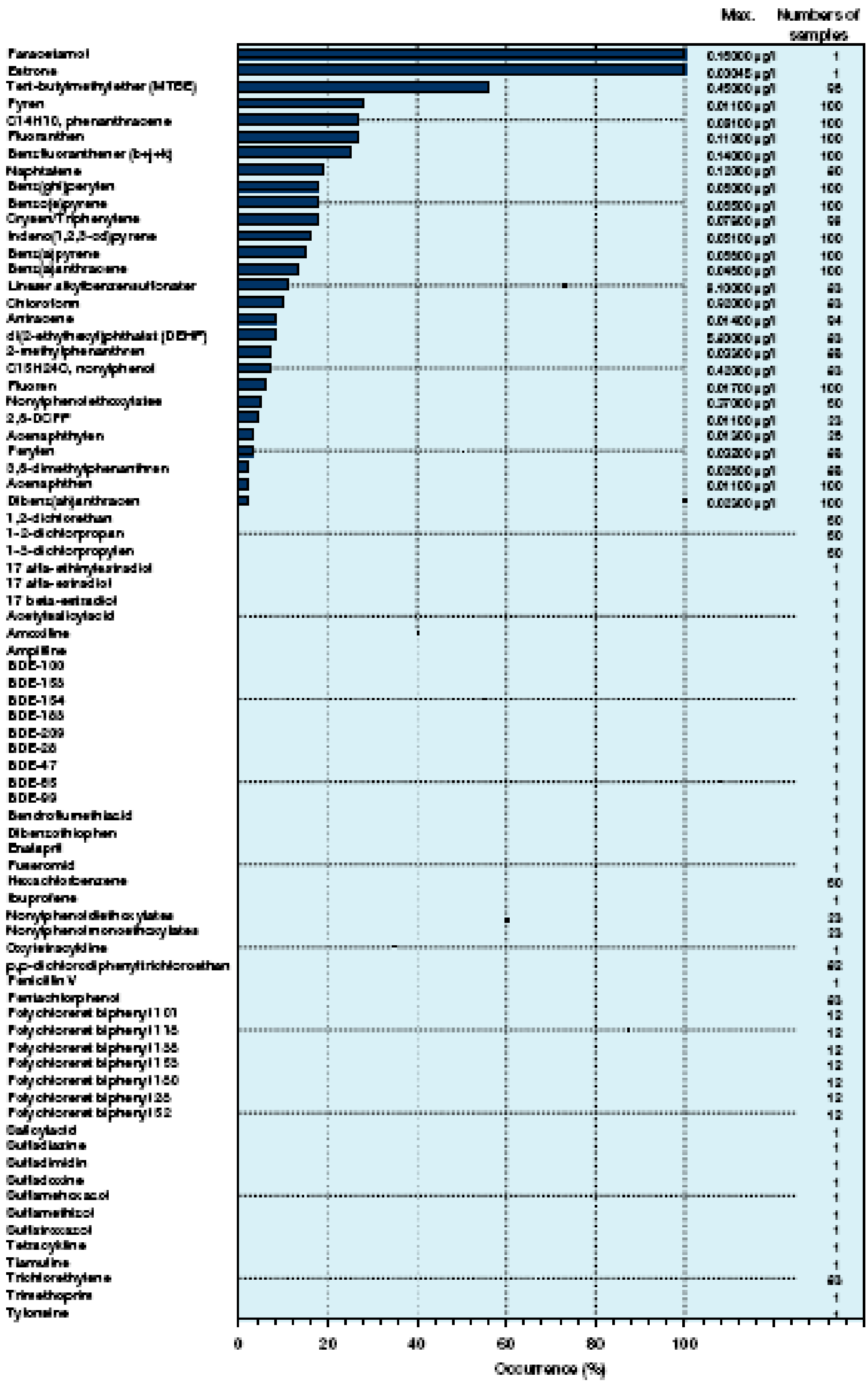

Figure 33. Occurrence of hazardous substances (excluding pesticides) in water from the river Odense at a station near the river's outlet and upstream of a large wastewater treatment plant (Ejby Mill WWTP). For each substance the table shows the number of samples collected and the highest measured concentration (µg/L).

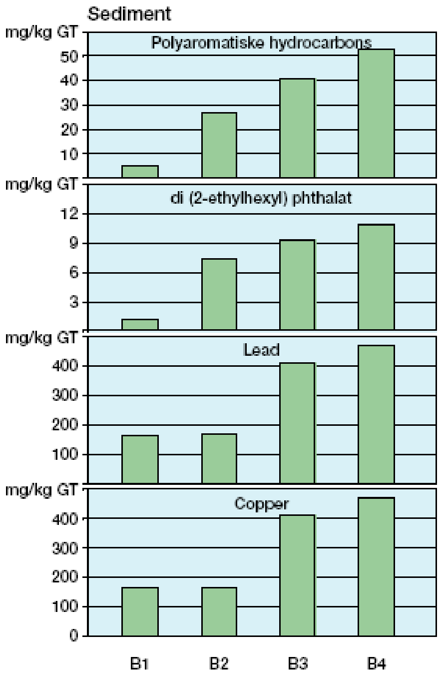

Figure 34. Hazardous substance content of sediment from the river Odense at four different locations (B1–B4) increasingly affected by stormwater discharges (see figure 27 for locations).

Table 10. Maximum annual mean concentration of PAHs and lead in the river Odense at a station near the river's outlet and upstream of a large wastewater treatment plant (Ejby Mill WWTP).

Substance	2000	2001	2002	2003	2004	2005	Quality standard[1]
Heavy metals (µg/l)							
Lead	0.749	0.108	-	-	1.01	**5.46**	3.2
PAH-compounds[2] (µg/l)							
Perylene	**0.002**	0	**0.004**	0	0	0	0.001
Phenanthrene	**0.004**	0	**0.007**	**0.004**	**0.012**	**0.010**	0.001
Dibenz(a,h)anthracene	0	0	**0.003**	0	0	0	0.001
Benz(ghi)perylene	0	**0.0012**	**0.008**	**0.001**	**0.006**	**0.007**	0,001
Benz(a)anthracene	**0.004**	0	**0.004**	0.0008	**0.003**	**0.002**	0,001
Flouranthene	**0.008**	**0.002**	**0.014**	**0.002**	**0.017**	**0.015**	0.001
Indeno-(1,2,3-cd)pyrene	**0.004**	**0.0012**	**0.007**	**0.0012**	**0.006**	**0.004**	0.001
Benz(e)pyrene	**0.005**	**0.001**	**0.008**	**0.0012**	**0.007**	**0.007**	0.001
Benzflouranthene	**0.009**	**0.004**	**0.019**	**0.002**	**0.014**	**0.013**	0.001
Flourene	0	0	**0.002**	**0.0012**	0.0007	0	0.001
Pyrene	**0.008**	**0.002**	**0.011**	**0.002**	**0.021**	**0.013**	0.001
Benz(a)pyrene	**0.005**	**0.0013**	**0.006**	**0.0011**	**0.004**	**0.005**	0.001
Crysen/triphenylene	**0.005**	0	-	**0.0012**	**0.010**	**0.008**	0.001

Notes:

1: Quality standard (Ministry of Environment and Energy, 1996).

2: The general quality standard for PAHs stipulated in the statutory order is 0.001 µg/l, while the limit of detection upon traditional analysis of water samples is presently 0.01 µg/l.

–: Either the full 12 analyses are not available or the substance was not analysed for in the year in question.

0: The substance has not been detected in concentrations exceeding the limit of detection during the year in question.

Bold figures indicate exceedance of the quality standard stipulated in Ministry of Environment and Energy, 1996.

Table 11. Pesticides and pesticide degradation products detected in lake Arreskov in 2001 and 2003 indicating the percentage of pesticide-positive samples and the maximum concentration. The approval status of the pesticides in 1993 and 2003 is indicated.

Substance	Occurrence %	Max. conc., µg/l	Approval status	
			1993	2003
2,6-dichlorbenzamid (BAM)	75	0.027	+	÷
Hydroxyatrazine	58	0.020	+	÷
AMPA	50	0.031	+	+
Trichloro-acetic acid (TCA)	50	0.27	+	÷
Hydroxysimazine	42	0.015	+	(+)
Glyphosat	33	0.049	+	+
Terbutylazine	33	0.017	+	(+)
4-nitrophenol	17	0.11		
DNOC	17	0.024	÷	÷
Simazine	8	0.010	+	(+)

Analysis of pesticides in six annual water samples (collected June–September) revealed a total of five herbicides and five herbicide degradation products (table 11). The most frequently detected substance was BAM, a degradation product of the herbicide dichlobenil, which was banned in Denmark in 1997. On one occasion (September 2003), trichloroacetic acid (TCA) and 4-nitrophenol were detected in concentrations exceeding the limit value for drinking water (0.1 µg/l). The concentrations of the remaining pesticides were below the limit value for drinking water. This limit value applies to groundwater abstracted for the water supply and in the present context only serves as a basis for comparison.

Of the 24 organic micropollutants (excluding pesticides) analysed for in water samples from lake Arreskov, only nonylphenols were detected in concentrations exceeding the limit of detection. This occurred in four of the 12 samples, with the concentration always being low (maximum 0.17 µg/l) and hence below the limit value for drinking water (0.5 µg/l).

Since 1980, Fyn County has analysed the heavy metals content of surface sediment from eight lakes in Odense River Basin. In addition, surface sediment from three lakes was analysed for a number of organic micropollutants in 2002 (87 substances in all).

In the majority of the lakes the heavy metals content of the sediment is lower than the quality standard, thus indicating that toxic effects on sediment-inhabiting organisms are unlikely. The concentrations are elevated in one lake, however, namely lake Brahetrolleborg Slotssø, which formerly received wastewater from a tannery. Here the concentration of chromium in particular is markedly elevated, while that of copper and nickel is slightly elevated.

The sediment in nearly all the lakes contains cadmium in concentrations exceeding the Danish limit value for sewage sludge intended for use as agricultural fertilizer. The cadmium mainly derives from agricultural lime and fertilizer, but is also present in ordinary household wastewater. In addition, the mercury content of the sediment exceeds the limit value in a few lakes. As the efforts made in recent decades to reduce mercury consumption in Denmark have considerably reduced losses of mercury to the environment, much of the mercury in the sediment probably derives from the use of mercury-containing products in the 1960s and 1970s. If restoration work involving sediment dredging is performed it will not be possible to use sediment from most of the lakes for agricultural purposes, and the sediment will instead have to be deposited.

Sediment from three of the lakes analysed for organic micropollutants (lake Arreskov, lake Langesø and lake St. Øresø) was found to contain a total of 26 PAHs (corresponding to 93% of the PAHs analysed for), six PCBs (50%), two phenols (50%), one LAS (linear alkylbenzene sulphonate) (100%) and one brominated flame retardant (11%). None of the samples were found to contain chlorophenols, nonylphenols, chlorinated pesticides, phosphotriesters, plasticizers or chlorobenzenes.

Surprisingly, the sediment of lake St. Øresø, which is otherwise a relatively clean, rather isolated lake, contains elevated levels of PAHs and is the only lake in which brominated flame retardants were detected. This can be due to the fact that the lake sediment is rich in organic matter, to which organic micropollutants particularly bind. Surprisingly too, LAS was found in the sediment from lake Arreskov despite the fact that it normally degrades rapidly.

Compliance with environmental objectives: The elevated levels of chromium detected in the sediment of lake Brahetrolleborg Slotssø could hinder compliance with the environmental objectives. Very little is known about the concentration of hazardous substances in the water phase of the lakes as systematic measurements have only been performed in lake Arreskov. The general assessment, though, is that hazardous substances do not pose a widespread problem for the lakes in Odense River Basin.

Due to the limited extent of the investigations it is not easily possible to assess compliance with the environmental objectives regarding hazardous substances. Fyn County is therefore of the opinion that it will be necessary to expand the lake monitoring programme for certain heavy metals and organic micropollutants in the future.

Groundwater: The groundwater bodies in Odense River Basin have been found to contain elevated levels of BTEXs (O-xylene and especially M+P-xylene), chlorinated solvents (chloroform and a few other substances), pesticides (mainly BAM) and phenols. Five of the groundwater bodies in the river basin have not been analysed. The status of 43% of the 37 groundwater bodies in the river basin is currently poor due to the presence of hazardous substances.

Odense Fjord, status: A number of studies have examined the content of hazardous substances in Odense Fjord and their effect on the fauna. A screening study of 110 hazardous substances (nine groups of substances) in sediment from Odense Fjord and elsewhere revealed that the concentration of several hazardous substances was sufficiently high to harm the biological structure.

This study has subsequently been followed up by national and regional monitoring of hazardous substances in sediment, water and mussels.

In Odense Fjord, a number of hazardous substances have been detected in sediment and mussels in concentrations exceeding international conventions in the area (table 13). The content of TBT, PCBs and PAHs is high in mussels from Odense Fjord compared with that at other stations on Fyn. The concentrations of both TBT and the PAH antracene far exceed the upper ecotoxicological assessment criteria set by the Oslo-Paris Commission (OSPAR) at which harmful biological effects are to be expected. Odense Fjord is thus one of the most TBT-contaminated fjords in Denmark, and mussel fishery for consumption has therefore been banned there. Among other substances the sediment contains PCB (seven PCBs) and a number of PAHs in concentrations exceeding the OSPAR ecotoxicological assessment criteria at which harmful biological effects cannot be excluded.

Table 12. Hazardous substances (µg/kg dry matter) in lake sediment. The samples were collected from the deepest part of the lakes in November–December 2002. The analyses are from the upper 2 cm of the sediment.

Substance	Lake Arreskov	Lake Langesø	Lake St. Øresø
PAH-compounds			
1-methylnaphthalen	1.8	4.4	2.9
2-methylnaphthalen	2	6	4.8
1-Methylphenanthren	2.3	3.5	7.5
2-methylphenanthren	5	5.1	8.2
acenaphthen		6.3	0.82
1-Methylpyren	3.9	6.2	7.9
Acenaphthylen	4.8	14	5.1
anthracen	5.8	12	9.3
benz(a)anthracen	38	39	50
Benzafluoren	16	26	42

benz-a-pyren	38	62	75
benz-e-pyren	43	74	130
benzfluoranthener - b+j+k	120	170	260
benz-ghi-perylen	48	53	100
chrysen/triphenylen	62	56	120
dibenz-ah-anthracen	12	13	20
dibenzothiophen	3.2		7,3
Dimethylnaphthalener	28	120	26
fluoranthen	89	110	190
fluoren	7.3	16	14
indeno-1,2,3-cd-pyren	72	76	150
naphathalen	8.5	8.2	11
perylen	19		41
phenanthren	33	42	45
pyren	68	91	130
Trimethylnaphathalener	3.1	4.9	5.4
Total	**734**	**1019**	**1463**

Substance	Lake Arreskov	Lake Langesø	Lake St. Øresø
PCBs			
PCB nr. 101	0.3	0.6	0.3
PCB nr. 138	0.8	0.9	0.5
PCB nr. 149	0.3	0.5	
PCB nr. 153	0.5	0.8	0.4
PCB nr. 180	0.3	0.4	0.3
PCB nr.118			
Total	**2.2**	**3.2**	**1.5**
Phenols			
Phenol	83	26	23
4-methylphenol		27	44
Total	**83**	**53**	**67**
LAS, mg/kg DW	6.4		
Brominated flame retardants (PBDE)			
BDE-209			4.2
Characterization of sediment			
Dry matter, %	6.5	17.1	5.5
Organic matter, % of DW	39	22	57

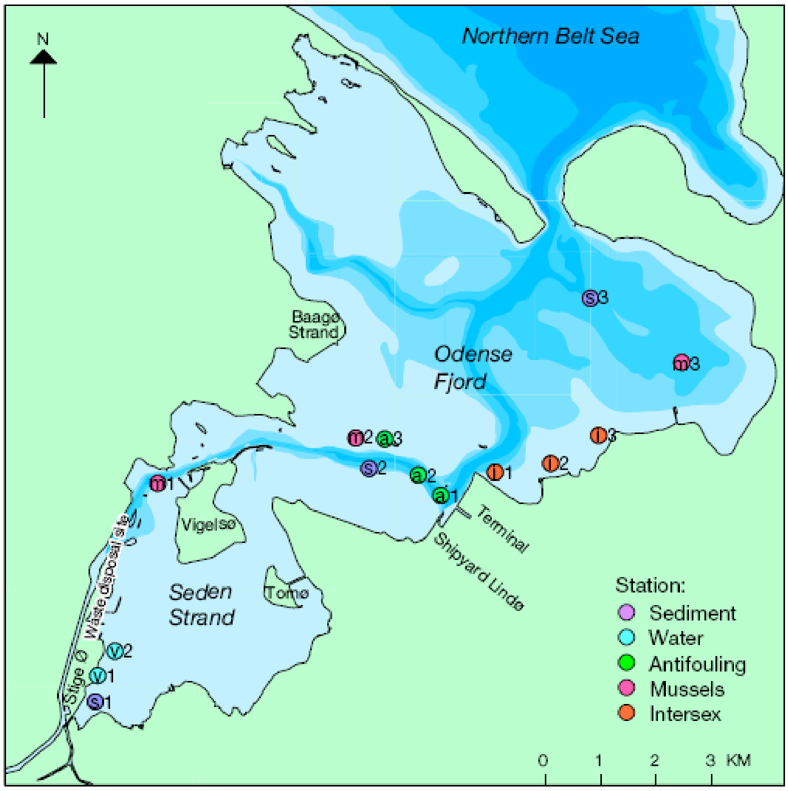

Figure 35. Location of the monitoring stations at which hazardous substances are monitored in Odense Fjord.

Table 13. Concentration of hazardous substances in water, sediment and biota (Odense Fjord).

Substance	Water	Sediment	Mussel
Organotin (TBT)	X*	X*	X*
PAHs	-	X*	X*
PCBs	-	X*	X
Phthalates	-	X	-
Nonylphenol	-	X	-
P-triester	-	X	-
Chlorobenzene s	-	X	-
Phenoles	-	X	-
LAS	-	X	-
DDT	-	X	X
HCH	-	X	<
HCB	-	X	<
Diuron	X	-	-
Atrazine	X	-	-
Brominated diphenylether	-	-	X
Heavy Metals	-	X	X

X: Substance detected
<: Content of substance below limit of detection
*: Substance exceeding the ecotoxicological assessment criteria (OSPAR)

In addition, the sediment has also been found to contain phthalates, nonylphenols, phosphotriesters, chlorobenzenes, phenols, LAS, DDT, HCH (hexachlorocyclohexane) and HCB (hexachlorobenzene). Moreover, the heavy metals copper, nickel, lead and mercury have been detected in the sediment in concentrations exceeding the background levels in the Kattegat.

Apart from the antifouling agents diurion, irgarol, atrazine, simazine and tributyl tin, no other hazardous substances have been analysed for in the water phase. Diuron and atrazine were found in concentrations above the detection limit, although the atrazine concentration was below the quality standard for water bodies (cf. Danish Ministry of Environment and Energy Statutory Order No. 921 of 8 October 1996), while the diuron concentration was below the proposed quality standard for water bodies. The TBT concentration exceeded the upper OSPAR ecotoxicological assessment criterion several-fold.

The fauna in Odense Fjord has been shown to be affected by the hazardous substances, and effects have been detected in gastropod molluscs, mussels and fish.

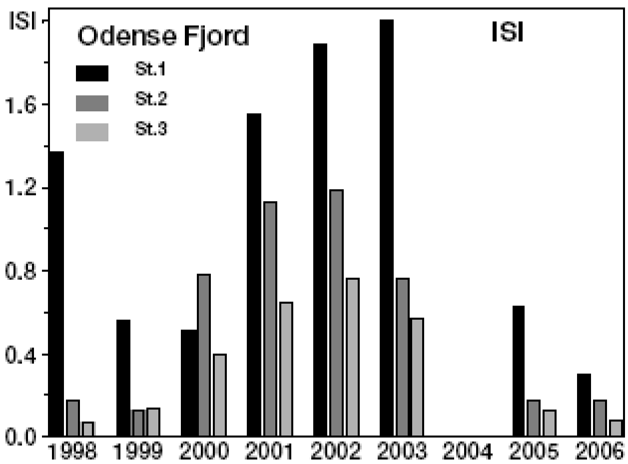

Figure 36. Intersex index (ISI) in female common periwinkles at three stations along a gradient from a potential source of TBT pollution over the period 1998–2006.

Many gastropod molluscs (common periwinkles) close to sources of TBT are affected by intersex and are on the way to becoming sterile (figure 36). Delayed gonadal development has been detected in soft-shelled clams (*Mya arenaria* Linnaeus*)* and common mussels *(Mytilus edulis* Linnaeus*)* in the fjord as compared to individuals living outside the fjord (Ærtebjerg et al., 2005). The gender distribution of soft-shelled clams in Seden Strand is abnormal, with a preponderance of males, while that outside the fjord is uniform (Gagné et al., in press). In eelpout, a greater proportion of the fry are stillborn and deformed compared with those born in reference areas, and detoxification enzyme activity is greater, thus indicating exposure to hazardous substances. In 2002, Fyn County initiated "Project Odense Fjord" encompassing a number of studies of the hazardous substance concentrations in the vegetation, benthic invertebrates, fish and birds and of the sources of the substances; in particular the possible role of hazardous substances in the decline of the eelgrass in Odense Fjord is being investigated. In connection with the project, Fyn County has collaborated with the University of Southern Denmark on an investigation of TBT in human beings living in connection with Odense Fjord. The final project report is expected at the end of 2006.

Compliance with environmental objectives: In assessing the measured concentrations of hazardous substances a number of different ecotoxicological assessment criteria have been used (Norwegian Pollution Control Authority, 1997: OSPAR, 1998; Swedish Environmental Protection Agency, 2000). These ecotoxicological assessment criteria, like morphological changes in the fauna caused by hazardous substances, have served as the basis for assessing compliance with the environmental objectives. As no data are available for water apart from a few analyses of antifouling agents in Odense Fjord, it is not easily possible to assess whether the coastal waters comply with the environmental objectives pursuant to Statutory Order No. 921 (Ministry of Environment and Energy, 1996) regarding the concentration of hazardous substances in the water phase. As a consequence, the assessment is mainly based on sediment and biota analyses.

The level of hazardous substances in sediment and biota from Odense Fjord is so high that the current environmental objective cannot be met for that reason alone. Moreover, considerable biological effects have been seen in the fjord due to the impact of hazardous substances. As general knowledge of the impact and effects of hazardous substances on the aquatic environment is poor, it is difficult to predict the trend. It is apparent, however, that several of the investigated substances that exceed the internationally applicable ecological assessment criteria and which have been banned for many years are still circulating in the environment, and hence can still be expected to be present in 2015. In Odense Fjord the present accumulation of hazardous substances in the sediment entails the risk that the environmental objective cannot be met by 2015. The problem is particularly great if the sediment is disturbed as the substances can more easily be released to the water phase.

III.7.3. Conclusions and recommendations

✓The available data are rarely sufficient to enable assessment of compliance with the environmental objectives for water bodies as regards hazardous substances. While the monitoring should be designed to meet the needs, it is the County’s opinion that there is a general need to increase the analysis frequency in order to comply with the WFD provisions regarding sampling frequency for hazardous substances, including priority hazardous substances. At the same time it will be necessary to expand the station network to include more localities in the monitoring programme for hazardous substances. Whether the relevant substances are included in the monitoring programme should be regularly evaluated, among other things on the basis of activities in the river basin, the status of the water bodies and screening investigations.

✓There is a need for clear guidelines on how compliance with the environmental objective for the water bodies is to be assessed as regards hazardous substances. The quality standards stipulated in the proposal of 17 July 2006 for the new directive would seem to provide the necessary basis for establishing such guidelines in the national legislation.

✓The investigations in Odense Fjord show that the effects of pollution with hazardous substances can often be seen in the biota and sediment before they can be detected in the individual sources of pollution. The discharge of low concentrations close to or below the limit of detection but in large volumes of water can input large amounts of hazardous substances that accumulate in the biota and sediment. There is therefore a marked need to establish special quality standards for biota and sediment for selected substances – just as the proposal for the new directive leads up to.

✓With some groups of substances the quality standards for water bodies are lower than the limit of detection provided by the analysis laboratories. When assessing and establishing quality standards for water bodies, efforts should therefore be made to ensure that the analysis techniques for the substances in question are developed and improved.

✓When issuing discharge permits for hazardous substances in the catchment area it has not previously been necessary to designate a transitional area around the discharge in which the quality standards may be exceeded. Through effective treatment and the use of the best available technology it has been possible to bring the discharges into line with the applicable quality standards for water bodies.

✓In order to be able to realize the WFD environmental objective regarding the phasing-out of priority hazardous substances it is necessary to chart the sources and transport pathways taken by hazardous substances to the aquatic environment, just as it is necessary to chart the occurrence and extent of hazardous substances in the aquatic environment in order to be able to initiate the planning of programmes of measures to protect the water bodies against further pressure from the substances.

List of priority substances in the field of water policy

Nr.	Name of priority substance	Identified as priority hazardous substance
1	Alachlor	
2	Anthracene	x
3	Atrazine	
4	Benzene	
5	Brominated diphenylethers	x
6	Cadmium and its compounds	x
7	C_{10}-$_{13}$-chloroalkanes	x
8	Chlorfenvinphos	
9	Chlorpyrifos	
10	1,2-Dichloroethane	
11	Dichloromethane	
12	Di(2-ethylhexyl)phthalate (DEHP)	
13	Diuron	
14	Endosulfan	x
	(alpha-endosulfan)	
15	Fluoranthene	
16	Hexachlorobenzene	x
17	Hexachlorobutadiene	x
18	Hexachlorocyclohexane	x
	(gamma-isomer, Lindane)	
19	Isoproturon	
20	Lead and its compounds	
21	Mercury and its compounds	x
22	Naphthalene	
23	Nickel and its compounds	
24	Nonylphenols	x
	(4-(para)-nonylphenol)	
25	Octylphenols	
	(para-tert-octylphenol)	
26	Pentachlorobenzene	x
27	Pentachlorophenol	
28	Polyaromatic hydrocarbons	x
	(Benzo(a)pyrene),	
	(Benzo(b)fluoranthene),	
	(Benzo(g,h,i)perylene),	
	(Benzo(k)fluoranthene),	
	(Indeno(1,2,3-cd)pyrene)	
29	Simazine	
30	Tributyltin compounds	x
	(Tributyltin-cation)	
31	Trichlorobenzenes	
	(1,2,3-Trichlorobenzene)	
32	Trichloromethane (Chloroform)	
33	Trifluralin	

Table 1.1 Monitoring program for harzardous substances (NERI, 2006).

	Point sources			Organic fertilizer	Atmosphere	Ground-water	Water-cources	Lakes	The sea		
	Waste-water	Sludge	Rainwater						Water	Sedi-ment	Biota
Heavy metals	x	x	x	x	x	x	x	x	x	x	x
Inorganic tracers						x					
Pesticides	x	x	x	x		x	x	x	x		
Phenols and chlorophenols	x	x	x	x		x	x	x	x	x	x
Alkylphenols	x	x	x	x		x	x	x		x	
Plasticizers	x	x	x	x		x	x	x		x	x
Detergents	x	x				x	x	x	x		
Organic solvents	x	x	x			x	x		x		
Ether (MTBE)	x	x	x			x	x	x			
PAH	x	x	x	x			x	x		x	x
Phosfotriesters	x	x		x							
Aliphatic amines	x	x									
PCB	x	x								x	x
Chloro-pesticides	x	x				x	x			x	x
Dioxin and furane		x									
Organotin-compounds										x	x
Medicines				x							

About Phase II of the Pilot River Basin Activity

Since the adoption of the Water Framework Directive in 2000, a Common Implementation Strategy (CIS) was set up to guide its implementation. In a first phase a set of guidance documents were prepared, which were tested by the Pilot River basins. The outcome of this exercise is reported in the 2005 Pilot River Basin Outcome report. In the second phase – running from 2005-2006 and coinciding with the third CIS work programme - the Pilot River Basins have been involved in the different working groups and other activities set up in the CIS, and a wide variety of topics have been subject to pilot exercises. More information can be found on the European Commission's Directorate-General for the Environment Website:

http://ec.europa.eu/environment/water/index.html

The views expressed in this report do not necessarily reflect the views of the European Commission. The contents of this report has not been assessed by the Commission for compliance with the requirements of Directive 2000/60/60, and practices described in the report may therefore not necessarily be compliant with those provisions.

III.8. GROUNDWATER

*This report was prepared by the Pilot River Basins **Tevere** (IT). More information about this river basin can be found in chapter II or at: http://ec.europa.eu/environment/water/water-framework/prbs.htm. The report addresses (one) specific aspect(s) of the common implementation strategy for the Water Framework Directive (Directive 2000/60/EC), as part of the second phase of a pilot basin river activity.*

III.8.1. Introduction

The main issues concerning groundwater in regard to the WFD and Daughter Directive implementation were tackled by the CIS within WG C. During the years 2005-2006 they were organized and divided into 4 sub-groups: Monitoring, Protected Areas, Discharges and Status and Trends.

Parallel to these activities the 'Background cRiteria for the IDentification of Groundwater thrEsholds' (BRIDGE) project within the 6th Framework Programme was carried out with the aim of identifying a common methodology for the definition of thresholds introduced by the Daughter Directive.

From all these activities, as it had already been underlined in the course of phase 1 of the PRB network activities, it emerged that a suitable definition of aquifer typologies, similar to the one foreseen for surface water bodies, is useful for a successful implementation of the WFD. Aquifer typology classification was introduced by Annex II which foresees the possibility for Member States to use this approach to support the definition of background levels.

Actually groundwater typology classification also involves other aspects. In the Tevere PRB experience different environments were identified, characterized by different models of water circulation, determined above all by different ways of interaction between surface and groundwater. Therefore, a correct representation of natural phenomena requires differentiated conceptual models and consequently different approaches to the study of hydrogeological systems. For the achievement of the WFD objectives a correct identification of the models is important first of all to maintain good quantitative status in groundwater, from which often the preservation of the surface base flow, necessary for the protection of dependent ecosystems, derives.

Relevant requirements of the Water Framework Directive
WFD 2000/60/EC arts. 7, 8, 11 par. 3e, 17, annex II par. 2
GWD 2006/118/EC on the protection of groundwater against pollution and deterioration

III.8.2. Tevere PRB: river basin top-down approach

The methodologies developed by Working Group C were applied to the Tevere river basin following a top-down approach which goes from the scale of river basin and hydrogeological environments down to the single aquifers and groundwater bodies. Special attention was given to the perennial surface water circulation fed by groundwater. The Tevere river basin is characterized by a marked rainfall reduction in the dry season (from June to September). In this period runoff is marginal, evapotranspiration reaches maximum levels and surface water circulation is almost exclusively sustained by groundwater discharge.

In the last decades the flow during the dry season measured at the mouth of the river basin gradually decreased from about 120-130 m^3/sec during the period from the end of the '700s to the beginning of the '900s up to 80-90 m^3/sec today. The flow decrease is in great part due to an increase in dissipative uses within the river basin for agricultural, industrial and household uses. Today the precipitation regime and scale is decreasing and undergoing modifications, probably as a consequence to global climate change, in addition to the impact on water produced by growing anthropogenic pressures on the territory. Our approach was divided into the following steps.

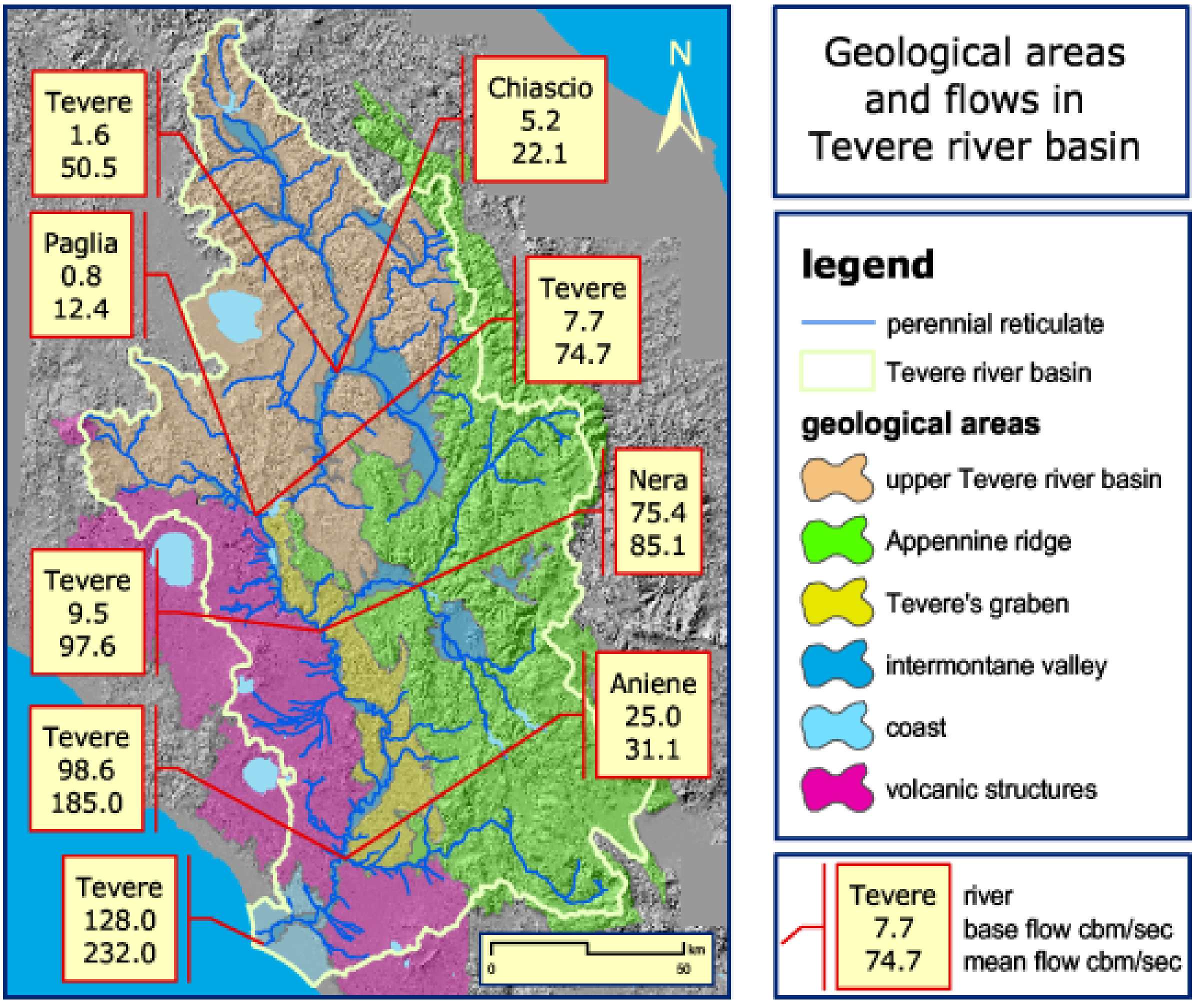

Figure 37. Geological areas with different models of water circulation. Flow measurements (from historical analysis) in the principal sections.

The surface water circulation was recreated considering the conditions existing before the presence of anthropogenic impacts and during the dry season.

In these conditions (hydrological reference conditions) the available water resource is given by the water stored in the aquifers and flowing in the perennial surface hydrographic network.

Imbalances between water resource supply and needs are clearly evident when we consider water resource availability during the dry season. Furthermore, surface water and groundwater interactions were identified. Subsequently for each hydrogeological complex and aquifer system that feeds the perennial surface hydrographic network a conceptual model was developed taking account of the artificialization of the system and the consequent impacts caused by pollution. The Tevere river basin comprises the following aquifer typologies (figure 38):

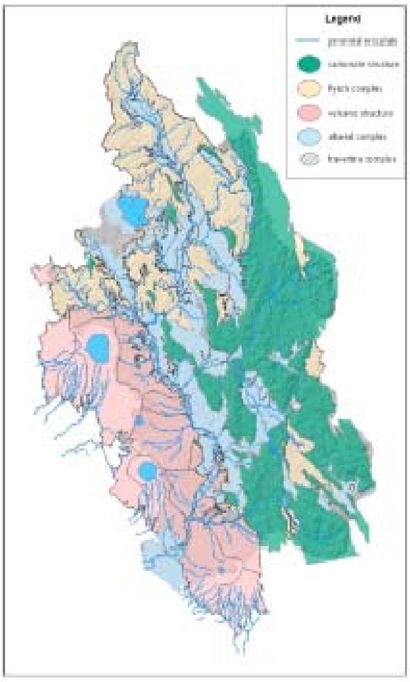

Figure 38. Aquifer typologies in the Tevere river basin

- ✓ Terrigenous complex aquifers of the Upper river basin (low permeability and scarce stored water volumes)
- ✓ Volcanic complex aquifers (medium permeability and abundant stored water volumes)
- ✓ Carbonate complex aquifers of the Apennine Ridge (high permeability, valuable and strategic water resources)
- ✓ Alluvial plain aquifers (from medium to low permeability, water resources with high pollution impact)

Volcanic and alluvial aquifers are characterized by strong quantitative impacts. Water quality is considerably deteriorated in the aquifers in the alluvial plains. The Management Plan will introduce measures aimed at limiting groundwater withdrawals within compatible values and reducing pollution. The first objective is to reach a point of equilibrium between water abstraction and recharge in each aquifer. The second objective is to increase the base flow towards the surface water circulation and to guarantee an adequate dilution capacity in the surface water bodies. In parallel for each aquifer the characterization of natural background levels, thresholds, and trend reversal values was carried out in accordance with the BRIDGE project indications. The third objective is to design integrated monitoring networks regarding qualitative and quantitative aspects. Each aquifer typology required a differentiated approach. The experiences in carbonate and volcanic aquifers are described below.

III.8.2.1. The carbonate systems

The reconstruction of hydrogeological conceptual models for carbonate aquifers was based on a detailed analysis of the complex geological situation that characterizes the entire calcareous ridge (figutr 39). The carbonate area is the richest area in groundwater resources. It is composed of complex hydrostructures containing several aquifers that feed numerous point and linear springs. It is mainly composed of basin and carbonate platform Mesozoic rocks separated by a transition area. The rocks were subject to intense tectonic translations which produced north-east verging fold structures.

In the basin area there are several hydrogeological structures with overlapping aquifers delimited by well-defined hydrostructural limits, mainly in meridian direction. It is possible to distinguish basal and perched aquifers that prevalently feed perennial watercourses and, to a lesser extent, point sources. In the carbonate platform area it is possible to distinguish extensive basal aquifers that feed large point sources.

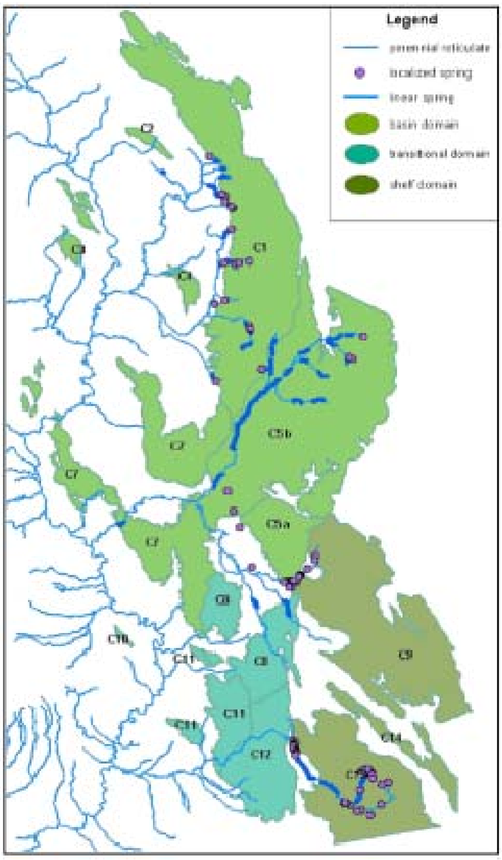

Figure 39. Aquifers in the carbonate Apennine ridge.

Anthropogenic pressures on these hydrostructures are relatively low due to their high altitude above sea level and consequently deep depth in respect to the ground level of productive aquifers, which makes well drilling difficult. On the contrary there are numerous withdrawals from point sources for drinking water use and from the surface hydrographic network for hydropower plants, which cause: flow reduction in mountain watercourses for bypassing of hydropower diversions, loss of continuity in the watercourses due to the construction of dams, reduction of the dilution capacity consequent to base flow reduction.

The study of these hydrostructures was essentially based on direct field surveys aimed at identifying all groundwater discharges and in particular the interactions between groundwater and surface water (Low flow assessment). For this purpose direct flow measurements in the riverbed, carried out in the course of many years on well-defined cross-sections distributed over all the perennial hydrographic network, were used. The available permanent gauging stations on the hydrographic network were not sufficient to define the territorial distribution, scale and regime of spring water resources and the water circulation.

For each discharge or group of discharges, the respective hydrogeological basin, the most probable extension of the recharge area, its possible hydraulic limits (stratigraphic or structural) and mean effective infiltration values were defined; where it was possible, the conceptual hydrogeological model was integrated with aquifer saturation levels (Piezometric Field) and the relative hydraulic gradients.

The volcanic hydrogeological systems are situated along an alignment parallel to the Tyrrhenian sea and were generated by activities that took place starting from the Late Pliocene epoch. These systems in order from north to south are: the Vulsini, Cimini and Sabatini mountains and the Albani hills (figure 40).

From a morphological point of view these structures are raised and characterized by a truncated cone shape. The water circulation radiates from the centre to the periphery, draining on one side towards the coast and on the other side towards the Tevere river. The recharge of the ground water circuits is constituted solely by effective infiltration. The radial disposition of the watercourses and the characteristic deep valleys connect groundwater to the surface through linear springs that feed the surface hydrographic network.

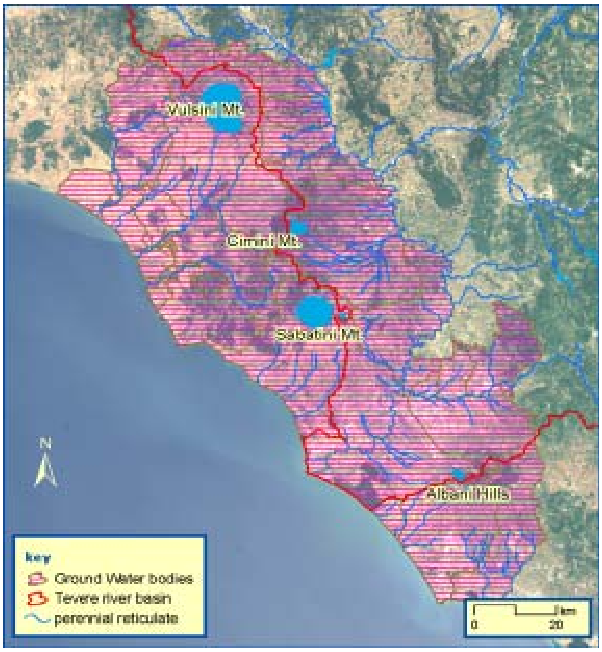

Figure 40. Water bodies in the Volcanic systems.

III.8.2.2. The volcanic systems

The mechanisms that regulate these exchanges are similar to those present in the carbonate sector with the exception of two substantial differences: minor ground water depth and minor flow. Furthermore, volcanic areas are less in relief, hilly rather than mountainous, and therefore exposed to more intense anthropogenic pressures. Intense groundwater extraction is widespread all over the territory and is feasible drilling not too far down in depth. This has caused the lowering of the piezometric level and consequently the reduction of the flows towards the surface and the dependent ecosystems.

Starting from a careful reconstruction of the physical characteristics of the volcanic structures and the piezometric surface derived from a measurement campaign on about 2100 points, water bodies, groundwater flows, recharge areas, and interactions with surface water were identified. The surface base flow sustained by groundwater was measured in about 650 sections of the perennial hydographic network (figure 41)

Therefore, on these aquifers it was possible to carry out a distributed parameter hydrogeological balance assessment on a monthly, annual and several-year basis. For this purpose geological, hydrogeological, meteorological, climatic, and land use data according to the water needs, were gathered in a geodatabase. In some sectors these data are being used to refine forecast scenarios for economic assessments on water uses.

The comparison of the piezometric surface from a measurement from 2002 with one reconstructed from data from the '70s showed some areas of strong lowering of the surface.

The hydrogeological balance confirmed an overall imbalance in the water bodies in the volcanic aquifers where the ratio between groundwater withdrawals and effective infiltration is 47%, with maximum values above 100% (Monti Vulsini 25%, Monti Cimini 43%, Monti Sabatini 27%, Colli Albani 71%).

Due to the necessity of intervening urgently an indicator system was set up in order to identify parts of the territory subject to strong pressures and impacts. The indicators regard: density of the identified wells, drinking water abstraction points, industrial water needs, agricultural water needs, the difference between the measured surface piezometric level and the mean value within a radius of 3 km (anomaly), the width of the saturated area, the ratio between withdrawals and effective infiltration (at water body scale).

This method allowed to identify areas characterized by high withdrawal concentrations (figure 42) which were defined as critical if the withdrawals were > 1600 m3/ha/year or worthy of attention if they resulted inferior to this value. Consequently the uses were identified and temporary measures were introduced in order to set available quantities, for new use requirements. The control system requires complex and integrated monitoring systems that will be derived from the existing ones with appropriate integrations and adjustments to the new WFD requirements.

Figure 41. Piezometric map of the Colli Albani, indicating the main groundwater flow directions, water bodies and rivers generated by groundwater interactions.

III.8.3. Common lessons learned

The Tevere river basin's experience underlines the need for a preliminary aquifer typology classification because hydrogeological conceptual models and pollutant transport and diffusion models require very differentiated approaches according to the different aquifer types. An integrated river basin scale approach which also considers the interaction between surface and groundwater circulation was useful. In Mediterranean river basins during the dry season surface water circulation is mainly fed by groundwater. This means that the interactions between surface and groundwater must be known in order to set up a program of measures aimed at the achievement of good status both in surface and in groundwater bodies. The Tevere river basin's experience showed that the identification of thresholds aimed at introducing measures to control and reduce pollution is very complex in volcanic aquifers (see the BRIDGE project's WP4 case study).

III.8.4. Conclusions and recommendations

The Tevere river basin's experience in regard to the implementation of WG C methodologies confirms the validity of the deliverables produced by the working group. However, it is necessary to underline that the prevailing conceptual model in such deliverables regards aquifers in large alluvial plains. This required an adjustment of the proposed methodologies to the aquifers that were identified and which are often subject to minor anthropogenic impacts but nevertheless require a high level of protection because they represent strategic drinking water resources.

The precipitation regime and scale variations recorded in the last years suggest that the reference hydrological condition definition based on historical data could require adjustments to the new climatic trends forecasted by studies on global climate change.

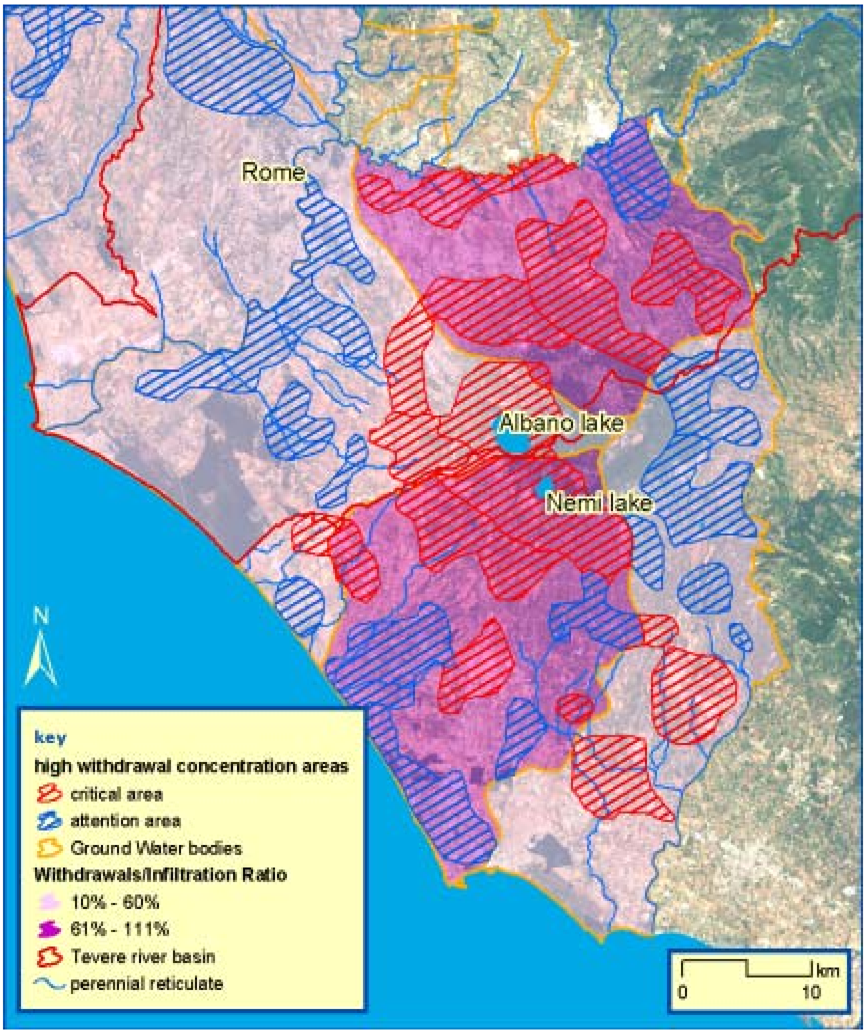

Figure 42. Areas with high withdrawal concentrations in Colli Albani water bodies.

About Phase II of the Pilot River Basin Activity

Since the adoption of the Water Framework Directive in 2000, a Common Implementation Strategy (CIS) was set up to guide its implementation. In a first phase a set of guidance documents were prepared, which were tested by the Pilot River basins. The outcome of this exercise is reported in the 2005 Pilot River Basin Outcome report. In the second phase – running from 2005-2006 and coinciding with the third CIS work programme - the Pilot River Basins have been involved in the different working groups and other activities set up in the CIS, and a wide variety of topics have been subject to pilot exercises. More information can be found on the European Commission's Directorate-General for the Environment Website:

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III.9. Reporting

*This report was prepared by the Pilot River Basins **Ebro/Duero** (ES) coordinator of the report, **Weser** (DE). More information about these river basins can be found in chapter II or at: http://ec.europa.eu/environment/water/water-framework/prbs.htm. The report addresses (one) specific aspect(s) of the common implementation strategy for the Water Framework Directive (Directive 2000/60/EC), as part of the second phase of a pilot basin river activity.*

III.9.1. Introduction

The River Basin Management Plan (RBMP) is the required instrument to involve the public and inform the EU. The basic content of the RBMP is outlined in annex VII of the WFD, but form, extent and information content will possibly vary from river basin to river basin. In order to simplify and harmonize the process of reporting, to enable a compliance check and to visualize the state of river basins with similar conditions in Europe, the data platform Water Information System for Europe (WISE) was developed.

Reporting sheets serve as templates and are already available for data on significant pressures and impacts as well as on the monitoring stations. Templates for data on quality elements for assessing the state of water bodies will follow soon. In prospect of water management issues, environmental objectives and the programme of measures further reporting sheets that fulfill the requirements of the WFD are presently developed.

Relevant requirements of the Water Framework Directive

- ✓ Article 15, on reporting, that establish the need to send copies of the river management plans and al subsequent updates and especially, the need to submit summary reports of analysis required under articles 5 and 8.
- ✓ It is also relevant to mention the article 18, on Commission report, based on the information submitted according to article 15.
- ✓ Article 20, on technical adaptations to the Directive, which offers the possibility to adopt technical formats for the transmission and processing of data, including statistical and cartographic data.

Apart from the Water Framework Directive, the pilot exercise has taken into account the principles of the INSPIRE Directive that aims the creation of an infrastructure for spatial information in Europe. Actually the exercise has developed an information system open and interoperable across Europe.

III.9.2. Duero/Ebro PRB case

Spanish activities on reporting aimed to implement a framework project with the goal of developing the necessary mechanisms and tools to perform the reporting according to the implementation plan for WISE.

Since this was a major project, the work was done by two Spanish river basins, the Duero and the Ebro. The authorities of both river basins coordinated together in order to build the required elements.

The two river basins have their own peculiarities; the Duero river basin is an international one, shared by Portugal and Spain, whereas the Ebro river basin shows a complex administrative situation, where it is necessary to coordinate the activity in a territory shared by nine autonomous regions. Regarding the reporting, the Duero river basin authority had no information system related to the WFD when the pilot activity started, whereas the Ebro river basin authority already had advanced systems running to handle water-related information.

The Spanish strategy for reporting is shown in figure 34. Two phases were set to achieve the goal. The first phase covered activities for 2006 and 2007 and the second one dealt with the activities for 2007 and 2008.

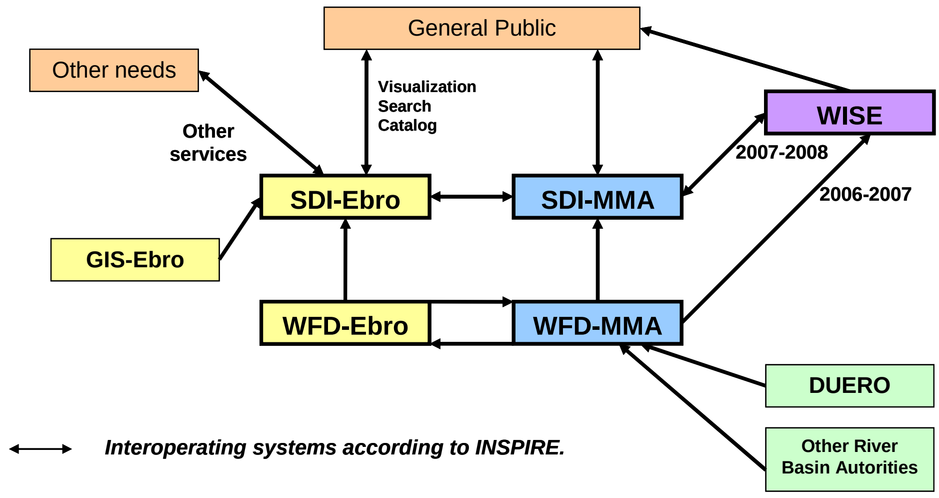


Figure 43. Summary of the Spanish Strategy for reporting to WISE.

A new information system and new features were implemented during the first phase:

✓ Regarding WFD-Ebro, new features were implemented to generate, together with the WISE Access Tools, the files to be transferred to WISE, which included alphanumeric information (XML) and geographic information (shape files). This task involved the checking procedure of the access tools.

✓ WFD-Duero was developed.

The new information has a data model similar to the Ebro information system, but with different procedures and interfaces. It stores the data required for article 5 on detailed information about the river basin district.

The aim of the second phase is to build the Spatial Data Infrastructure (SDI) nodes in line with INSPIRE specifications. It is also intended for the nodes to interoperate with WISE, improving the current procedures for data loading. Therefore:

The SDI-Ebro is being implemented by Ebro PRB. This node retrieves the data stored in the WFD-Ebro database and publishes it on the Web through standard services.

The final goal of the framework project is to provide the data and procedures to comply with the Commission reporting requirements for articles 5, 6 and 8 of the Water Framework Directive. This covers the description of the river basin district, the environmental impact of human activity, the economic analysis of water use and the monitoring networks.

At a national level, the information system will be able to connect with the one developed by the Ministry of Environment through standard interfaces. Since it is the Member State that will report to the European Commission for all the Spanish river basins, the Duero river basin Authority and the Ministry are permanently in contact to ensure it.

III.9.2.1. This is how we approached it

The tasks carried out within the reporting activity began in the Ebro with tests and checks from the WISE system and successive versions of Access Tools supplied.

It was seen during this phase how the administration dispersion of the information could be a source of heterogeneity of criteria. Indeed, the majority of the territory administratively depends on the Ministry of the Environment, which decentralises its activity in favour of basin authorities, while the latter integrates territories from several autonomous regions. On the other hand, those basins that are integrally situated within the territory of one single autonomous region have competent authorities that directly depend on the autonomous government. The internal basins of Catalonia and the Basque Country are in this situation; they both have part of their territory administered by the Ministry (through the Ebro Basin Water Authorities), and another part administered by the actual autonomous government. However, with respect to the citizen information services, the vocation of these regions is to house the information about their entire territory in a homogeneous manner.

The reporting obligation falls upon the State, which must gather, homogenise and validate this information before sending it to the EC. Under these circumstances, and in view of the foreseeable source of dispersion of data and criteria, the current state of the information was diagnosed to carry out the necessary harmonisation foreseen in the system.

Parallel to this, and within the framework of the implementation work of the WFD, the Planning Office developed a WFD-Ebro database, which houses as much information as necessary to inform of the district characteristics (article 5). After overcoming the milestone of the 2005 district, a system was developed for the WFD-Ebro database, which, based on the Spatial Data Infrastructure (SDI) technologies and in line with INSPIRE specifications, was able to automatically interoperate with WISE and would render standard services within a web portal.

Duero river basin moved a step forward since there was no information system running when article 5 and 6 reports were submitted. This fact had the disadvantage of requiring considerable effort to get it running. On the other hand, it had the advantage of starting from scratch. This would make it easier to comply with WFD requirements, WISE implementation and INSPIRE principles.

III.9.2.2. Development of WISE

As a contribution to the development of WISE tools (http://wise.jrc.cec.eu.int/wfdview/php/index.php), verifications of the system were performed as users and the successive versions of Access Tools were checked, in connection with loading information related to article 5 of the WFD. The diagram used to analyse Access Tool and the XML diagrams is shown in figure 44. The information of Article 3 was also entered into WISE, including the text part by means of the forms available in WISE for the purpose and the spatial part in the form of shapefiles, according to established templates. This work resulted in a series of improvement proposals with respect to handling the tool supplied. A report was prepared with these proposals and this was sent to the WISE designers. This report describes the problems found related to the data and functionality of WISE or the Access tool provided. The main question that emerged from the system verification is that in its current state, the mechanisms to disseminate INSPIRE information and the report mechanisms to the Commission through WISE use different philosophies and technologies to transmit the same type of information. It would be desirable in this sense to make a change in the WISE design philosophy to use Spatial Data Infrastructure and INSPIRE principles.

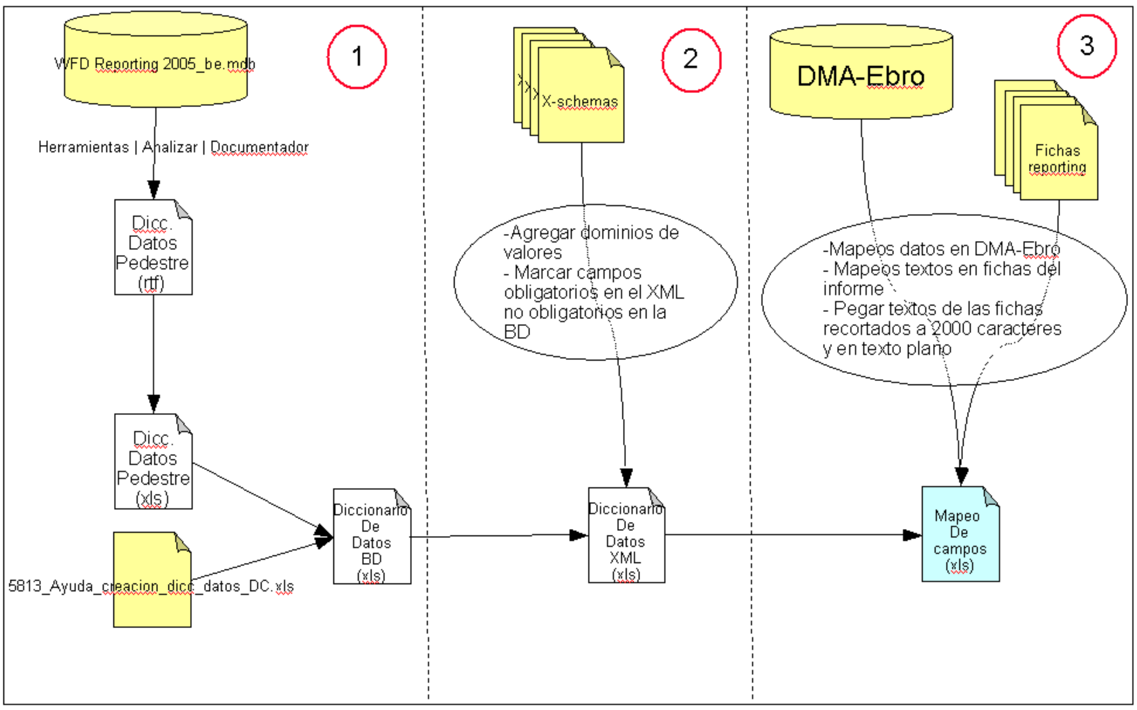


Figure 44. Methodology used to analyse the Access Tool and the XML diagrams.

III.9.2.3. Creation of a node for the Spanish spatial data infrastructure in the Ebro Water Basin Authorities

The WFD –Ebro system was developed in the first activity phases to house all the information required by article 5 of the WFD. Based on this experiment, an SDI node is being designed with the following purposes:

✓ Develop an infrastructure for the internal exploitation of the data related to the WFD

✓ Make the data visible to the public in general from a Web portal

✓ Act as a reporting tool for the Ministry of the Environment, which is responsible for sending the information to the European Commission through WISE.

✓ Act as a pilot experiment to create a spatial data infrastructure in other water authorities to satisfy WISE reporting requirements.

The node architecture follows the INSPIRE model, based on 3 layers: data, services and applications. The data sources will be made up of the WFD-Ebro database and other existing data units in the Ebro Water Basin Authorities, not specific of the WFD, but for use as support cartography. The metadata of all the data to be supplied will be stored in an Oracle database and will be conforming to ISO standard 19115.

The basic services of this system will include the catalogue service (search for metadata), nomenclature service (publication and search for toponyms in the different languages that exist in the demarcation), geographic display service (WMS), geographic entity service (WFS, which provide geographic and tabular information about the geographic entities stored).

All these services will be accessible by user applications through the Internet HTTP and, in agreement with the standard existing interfaces, defined by the Open Geospatial Consortium (OGC), so the interoperability INSPIRE principles are guaranteed as well as the scalability and integration of the SDI-Ebro services in other spatial data infrastructures.

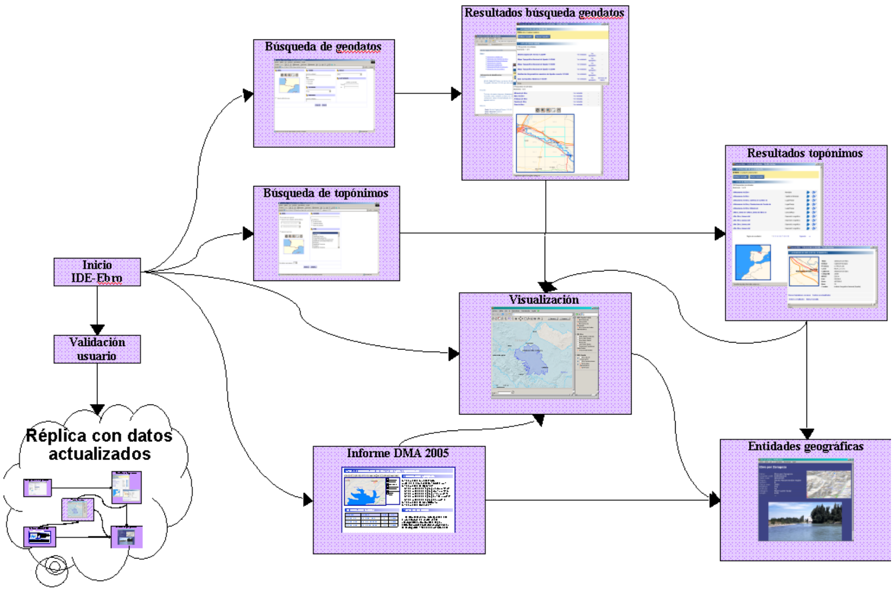


Figure 45. Prototype of the browser outline between SDI-Ebro applications.

The tasks carried out to date include:

- ✓ Start-up of a hosting company service and installation of the database therein.
- ✓ Cataloguing tool
- ✓ Catalogue service
- ✓ Metadata search engine
- ✓ Graphic design of the SDI-Ebro portal
- ✓ Design of the multi-lingual nomenclature service
- ✓ Design of the geographic entities server

Figura 46. Web Portal of the IDE-Ebro.

III.9.2.4. Creation of WFD-Duero

Duero´s approach focused on the implementation of an information system for the Duero river basin to store the information generated for the article 5 reports. The goal of the application is not only to collect the data reported, but also the relevant information related to it.

The tool was released after the article 5 reports submission, which would make it easier to review the data reported. From that point of view, it would make it easier to prepare the information in order to report it to WISE.

The design follows a three-phase approach. The different functionalities will be implemented in each one:

- ✓ Creation of the WFD-Duero data model to contain the information related to the characteristics of the river basin district specified in article 5. In order to use it, a two-layer application (a client and a server answering request) was created.
- ✓ Implementation of a Web application consisting of Web forms to display and edit the tabular information, and also to display and select geographic information.
- ✓ Improvement of the data model to store information on the environmental impact of human activity, the economic analysis of water use and the monitoring of networks.

WFD-Duero is currently in the design phase of an SDI node, since it contains a map server and it is possible to create catalogue, gazetteer, feature server modules, etc. all of them according to INSPIRE principles. This permits handling not only the specific data related to the Duero river basin, but the data related to different SDI nodes.

Phases 1 and 2 have been completed. Figures 47 and 48 shows the architecture of the information system and the three layer implementation. As a summary, the information system has the following features:

- ✓ Spatial viewer.
- ✓ Tabular data editor.
- ✓ Ground water bodies report.
- ✓ User identification

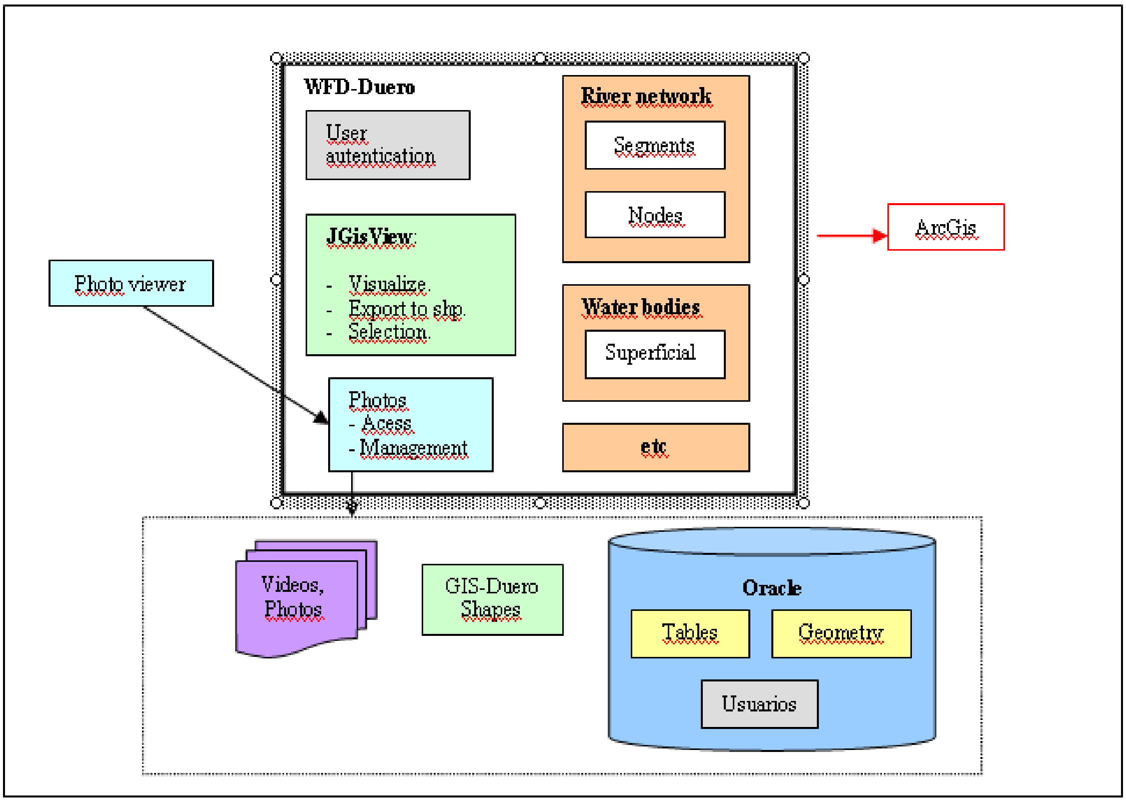


Figure 47. Architecture of WDF-Duero.

The new application allows, by means of the form, accessing the alphanumeric data by selecting an item on the map; exporting the layer to shapefile format; using the usual SIG tools, such as zoom, pane, distance measures, etc.); and displaying and editing segment rivers, lakes, water bodies, photos, etc.

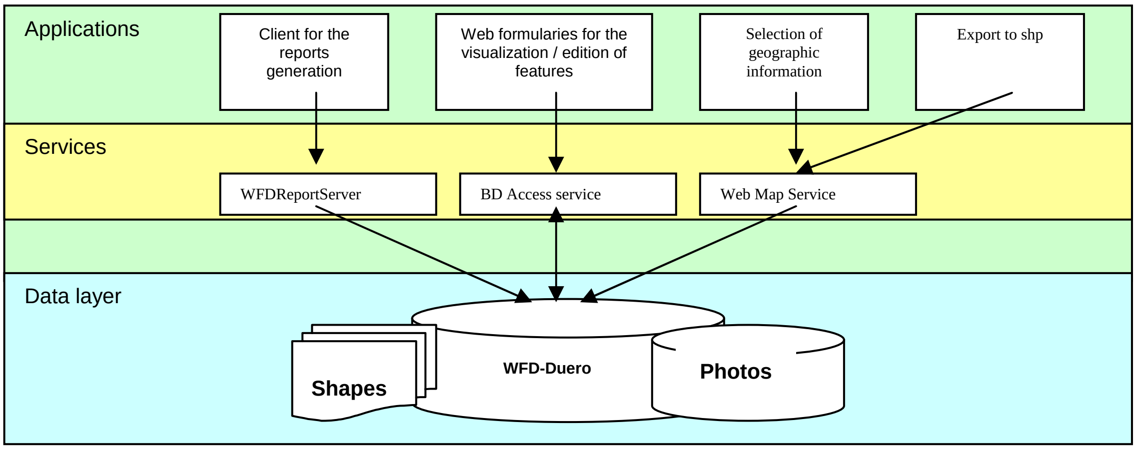


Figure 48. High level architecture diagram for the information system.

The tool will also be enhanced by improving the data model to include the environmental impact of human activity, the economic analysis of water use and the monitoring of networks, etc. Figure 49 shows the general overview of the Web application.

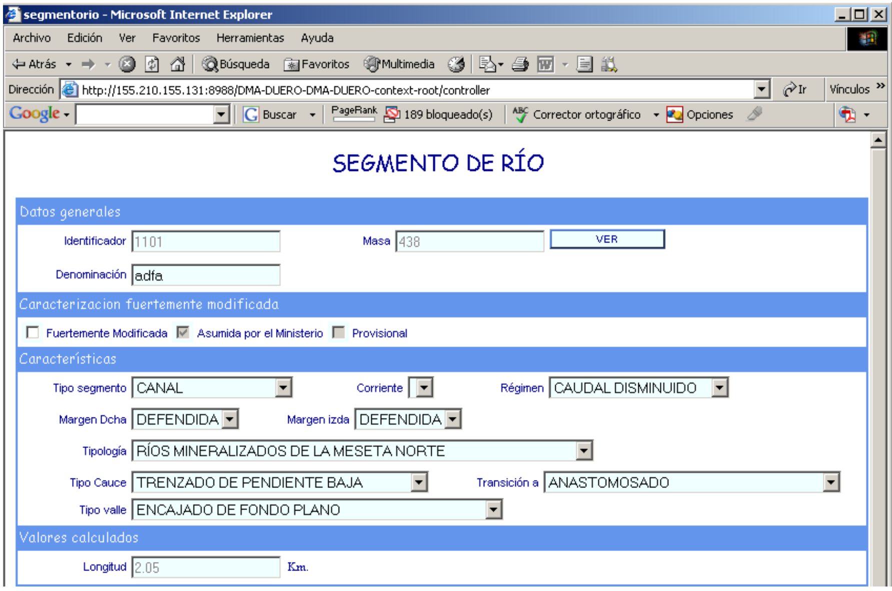


Figure 49. WFD-Duero through Web.

III.9.2.5. Diagnosis of the information status

The Ebro and Duero basins present some administrative characteristics that must be taken into account in the information process to the WISE system.

Nine autonomous regions are involved in the territorial scope of the Ebro basin. Two of them, the Basque Country and Catalonia, have responsibilities in water matters over their internal basins, and they manage information related to the WFD on their entire territory in a homogeneous way.

In the territorial scope of the Duero basin the presence by surface of the Castile and Leon region stands out, together with the presence of others such as Galicia and other residual ones. The most outstanding aspect of this basis is its international nature.

On the other hand, during the tests to load data into WISE this heterogeneity was noticed related to the limits of the different demarcations that the different competent authorities housed in their respective geographic information systems. Under these circumstances, the decision was made to verify how this administrative dispersion might affect the information process into the WISE system, given that this requires standardisation of formats and contents.

The main questions that emerged from the verification were:

- ✓ Language: The Catalan Water Agency uses the Catalan language for the majority of the information housed and, in a subordinate manner, Spanish or English. The other competent authorities use Spanish.
- ✓ Georeferencing: The Basque Country has data in UTM30, as does the basin authority. The Catalan Water Agency has data in UTM31.
- ✓ Cover: Both the Basque Country and Catalonia have vocation to cover their entire territory, although only the Basque Country does so to date.
- ✓ Limits: There is no agreement among the different competent authorities about the demarcation limits. The geographic information systems show differences, although generally on a small scale, in the contours of their respective scopes. In general, these are discrepancies attributable to different digitalisation origins (and at different scales). However, there are some cases of differences of assignment criteria.
- ✓ Scale differences: In accordance with the different problems that concern both the central and autonomous administrations. In particular, the Basque Country and Catalonia have information on a much smaller scale than the information used by the river basin authority.
- ✓ Meanwhile, the analysis of the information provided by the autonomous regions has disclosed that there are no homogeneous classification criteria in connection with transition and coastal water bodies.

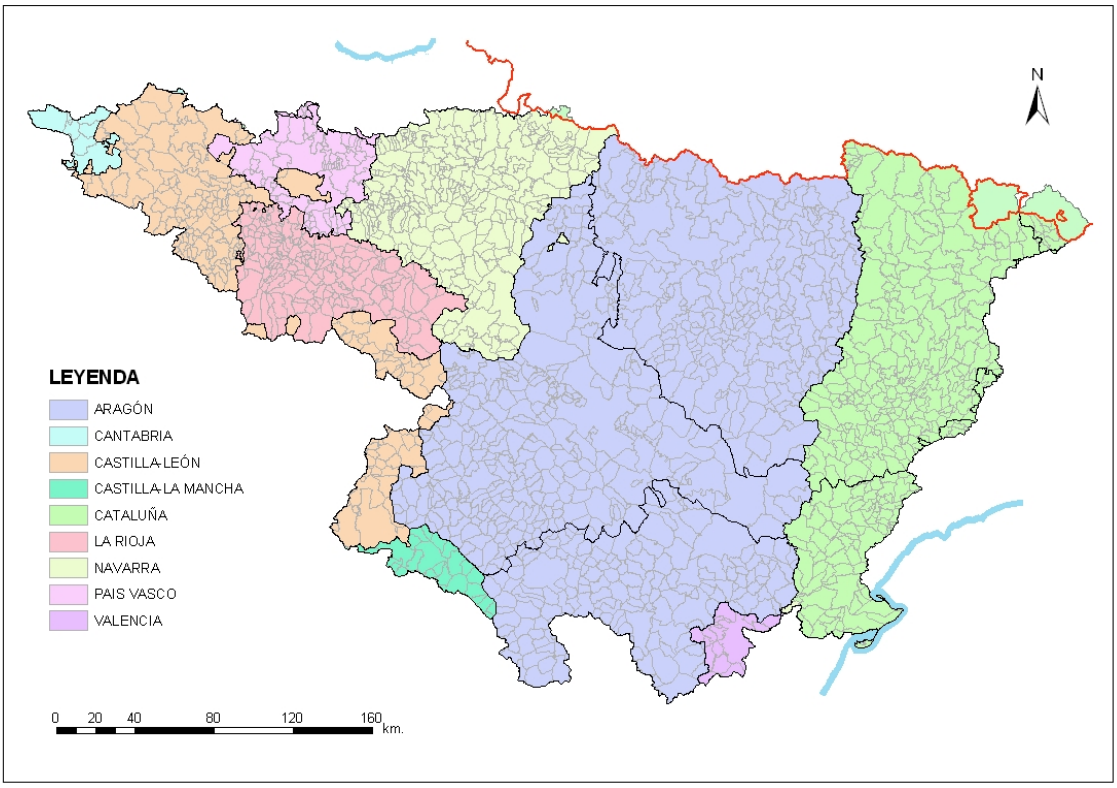


Figure 50. Example of the different Autonomous regions in the Ebro districts.

III.9.2.6. This is what we learnt.

The next proposal for approval of the coming INSPIRE directive will set up standards and protocols regarding technical, organisational and coordination aspects, together with policies that involve the access, creation and maintenance of geographic information that is relevant for the European Community.

Regarding this, both Ebro and Duero River Basins authorities have made a great effort during the PRB activities in order to create SDI nodes. The objective is to provide the Spanish River basin authorities with a pilot experience, so that it will be easier for them to comply with the reporting to WISE requirements. It is also intended that one of the outputs will be the creation of a public Web site.

The output and the knowledge achieved during the SDI node development is part of the technical documentation associated to the project. It is important to mention, though, the importance of the metadata linked to the geographic information. There are two points of view regarding them; from the producer point of view, metadata are information descriptors; from the consumer point of view, metadata are part of the mechanisms for data mining. During the development of the projects, it was proved that existing metadata in the offices of Water Planning have some problems regarding the data mining processes, since when created there was no catalogue standards and thesaurus were not widely used.

Apart from the technical problems, the pilot exercise helped to identify the coordination and harmonization issues involved in the different responsibilities in water management; the local, autonomous and national administrations have taken over. The most relevant issues are:

- ✓ In general, it is welcome by all authorities the idea of creating information systems able to interoperate in order to provide information to the UE.
- ✓ There are different criteria regarding the identification of water bodies. There are no common criteria either in the mechanisms, systems or languages to store the data.
- ✓ The requirements for data aggregation are different. This means that there are different information levels, which make it difficult to automate the process for the information systems to interoperate.

To end with, the pilot exercise proved the importance of the information systems (hardware, software, human resources and procedures) on the water planning development. Having a useful system will make the planning process much easier. This also includes the participation process, grace to the creation of the web site for participation.

III.9.3. Weser PRB: Harmonisation of Reporting and Visualization of Reporting Data

To find out about adequate reporting units as well as suitably aggregated information, the Weser PRB has come up with first ideas towards the content and structure of the reporting sheets concerning environmental objectives and the programme of measures and visualized the information using real issues and test data.

III.9.3.1. The reporting units

The WFD refers to water bodies as the management unit. The variety of objectives and measures that will be identified for each water body cannot appropriately be reported without aggregation. Therefore, for further reporting purposes it is necessary to summarize the information. Detailed and precise information will nevertheless be at hand for implementation at the level of water bodies, group of water bodies or regional management units. The information for water bodies can be summarized for a sub unit and the number or length of water bodies that are concerned regarding certain pressures, states, objectives or measures can be transmitted to supplement the River Basin Management Plan.

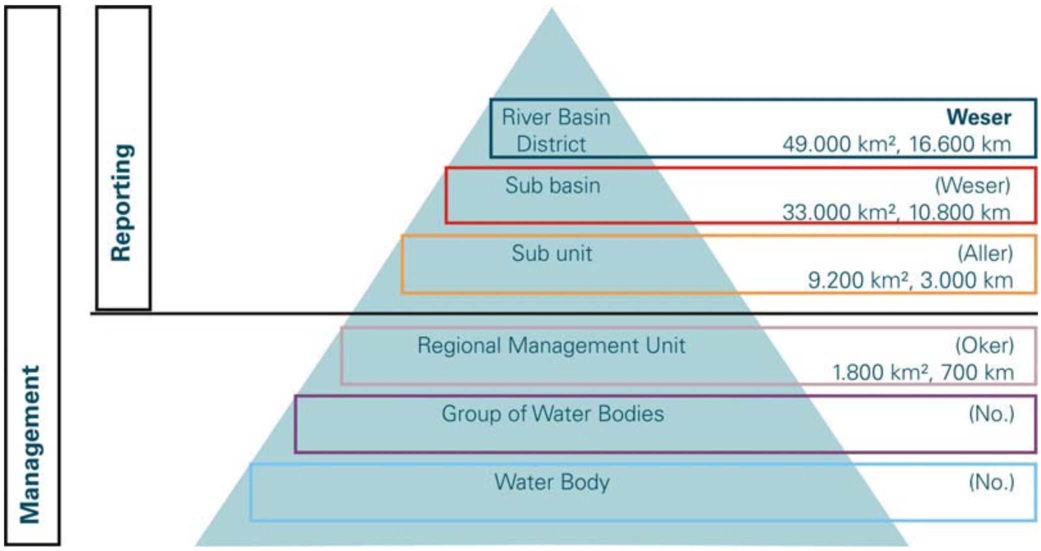


Figure 51. Reporting and management levels with respective catchment size and total length of water bodies (rivers and streams).

At river basin district level the information content especially for large river basins does not seem to be differentiated enough and, furthermore, the variable sizes of the RBDs do not allow for comparisons. Therefore, reporting is envisaged at different levels: river basin, sub basin and sub unit. On a larger scale, from sub units down to water bodies, the information needs to be aggregated for reporting purposes (figure 51). As the Weser River Basin is a solely national river basin, the sub basin boundaries are actual catchments in contrast to international river basins where sub basins could be defined as member state's part of a river basin. For the purpose of visualization, it is recommended, to divide sub units of a size from 5000 to 20,000 km². In the Weser River Basin sub units with a catchment ranging from 5500 to 9200 km² represent suitable reporting units (figure 52).

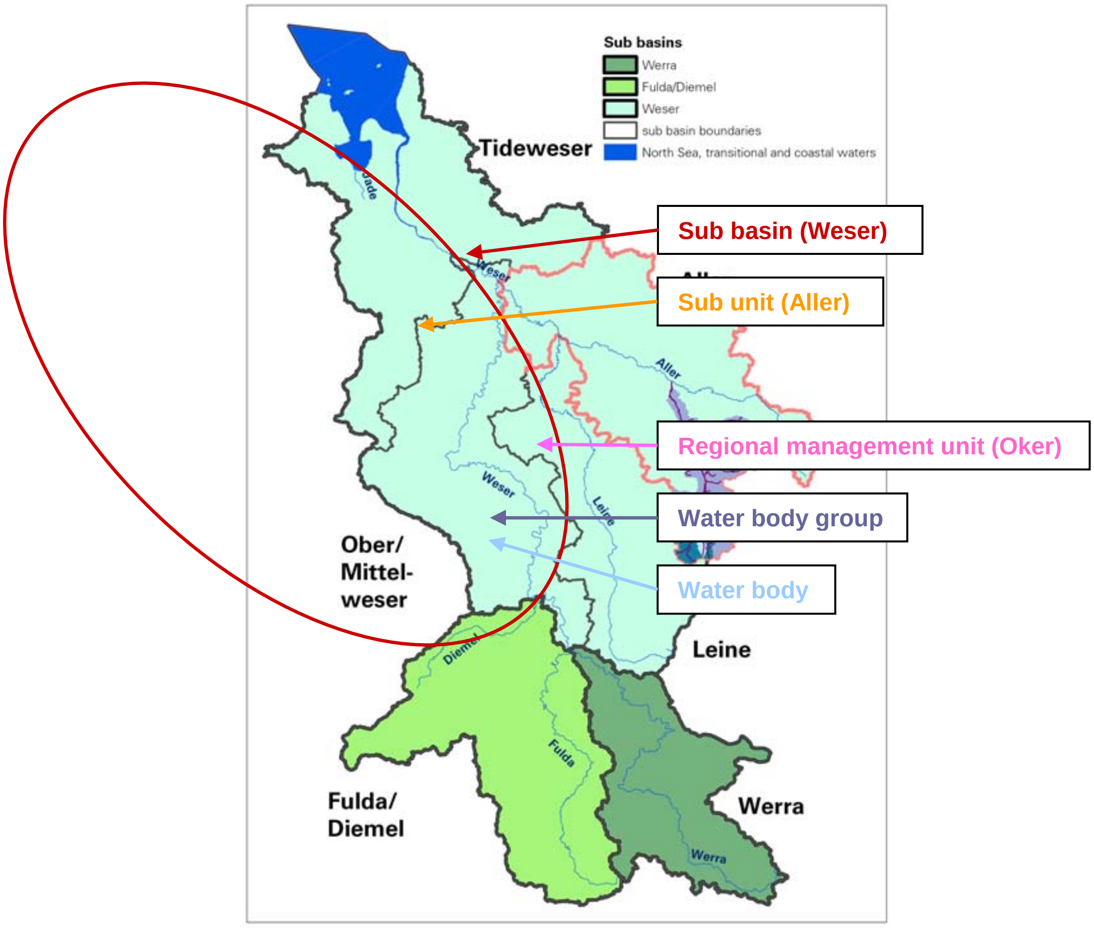


Figure 52. Reporting and management levels Weser River Basin.

III.9.3.2. Visualizations of objectives and states at sub unit level

Environmental objectives and management issues have to be identified at different levels. The pressures caused by morphological alterations and transversal obstructions are generally regarded as main issues in the river basins. In order to improve the hydromorphological status, several aspects have to be looked at, one of them being river continuity, objectives and resulting measures have to be identified. Especially on the fish coenosis, the longitudinal continuity has a strong impact. In this context, the aspect of continuity in the main rivers of the Weser system as well as the linkage and improvement of spawning and nursery habitats will be dealt with at a river basin wide scale as well as at regional level. The sectoral or pressure specific approach, in this case river continuity, has the advantage of looking at a certain pressure and hence, facilitating the identification of pragmatic objectives and measures. Furthermore, longitudinal continuity is one of the hydromorphological elements for the classification of the ecological status. However, in the end it is the overall status that is crucial and the sectoral approach presents only steps on the way to achieve the WFD objectives.

The examples of visualizations given below are just simplified illustrations and do not reflect results of the ongoing process. There are still several aspects to be looked at in deriving objectives and measures and there will be more differentiated information available than presented in these maps. The indication and visualization of the status of river continuity as one sectoral aspect using the required biological components is still another issue that needs to be considered.

Visualizing present states, objectives or in 2015 (2021 or 2027) the respective state of the environment indicating the effect of measures, the sub unit represents a suitable size. The map (figure 53 left) illustrates the case that diadromous fish species which migrate from sea to freshwater and vice versa have a free passage from the mouth of the Weser upstream to the boundary of the sub unit Tideweser (green). The sub units further upstream are presently not accessible for long distance migrating fish species, hence, longitudinal continuity is not yet achieved.

In the process of identifying objectives and drawing up a Programme of Measures priorities will have to be developed to apply measures with the most cost effectiveness. The map “objectives” (figure 53 right) will be the result of the process on deriving objectives and identifying priority areas and measures. In the illustrated case longitudinal continuity for long distance migratory species will be aimed at in the grey coloured sub units, whereas in the white coloured sub units there are no measures necessary.

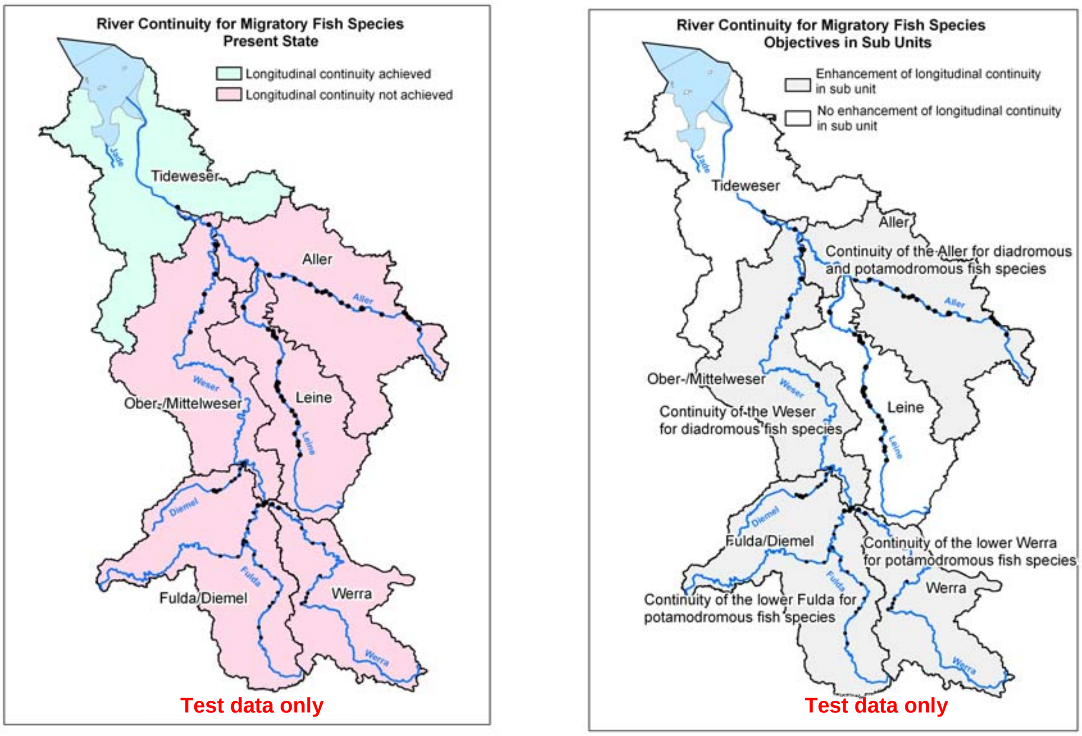


Figure 44. Visualization of the present state (left) and of objectives (right) of sub units regarding river continuity; test data only.

The progress that is achieved in implementing the programme of measures will have to be presented in the targeted years of 2015, 2021 and 2027 (figure 54). Illustrating a possibly most cost effective solution, longitudinal continuity will be achieved in the main rivers of the Weser system connecting one sub unit after another starting at the mouth of the Weser. However, the accessibility of spawning grounds and nursery habitats in the sub units will be the decisive factor, not just if the sub unit itself is connected.

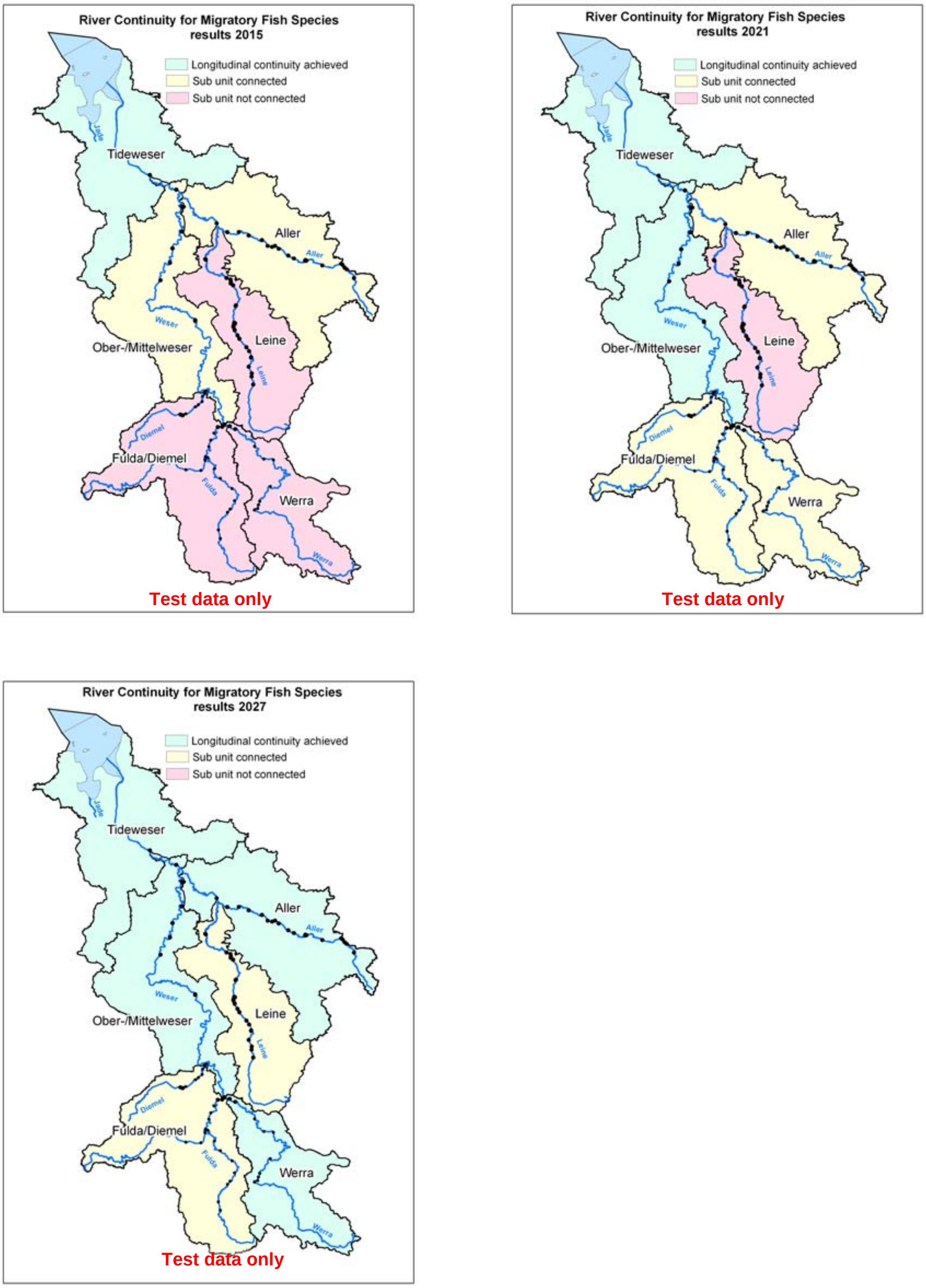
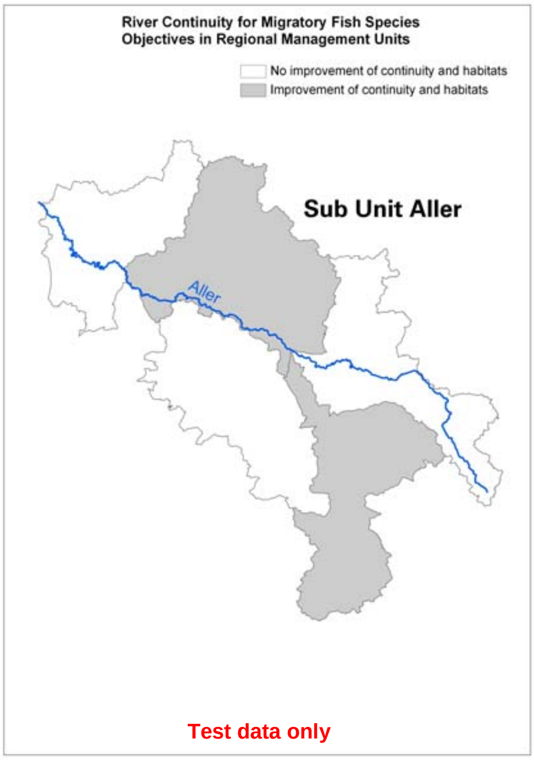
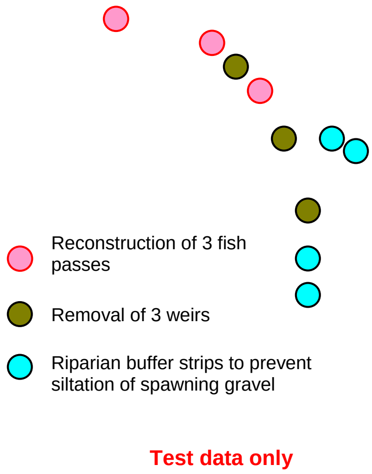


Figure 54. Visualization of results (states) of sub units in 2015, 2021, 2027 regarding river continuity (test data only).

At larger scale objectives and measures will be concretized for each water body or a group of water bodies. These have to comply with the river basin wide concept that will be developed in a top down approach. Unlike the visualization for the European comparison of approaches there will be more detail necessary to ensure public participation and the realisation of measures at any level below the sub unit. This detailed data cannot appropriately be visualized due to the abundance of information. Other objectives for the regional management levels concerning migratory fish species could be e.g. the improvement of habitat morphology. Figure 55 presents objectives and figure 56 measures at the level of regional management units.





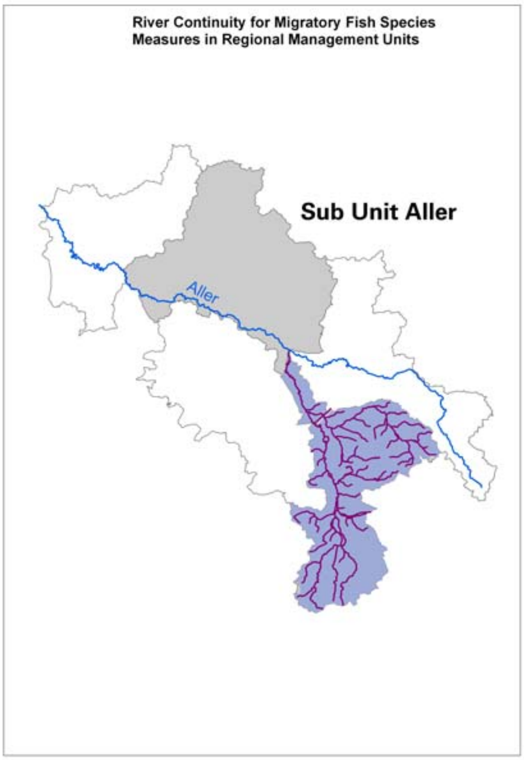


Figure 55. Objectives at management level regarding river continuity and habitat improvement (test data only).

Figure 56. Measures at the level of regional management units regarding river continuity and habitat improvement (test data only).

III.9.4. Conclusions and further steps

In order to fulfill the requirements of the WFD and to enable a compliance check of the WFD implementation in the river basins, the aggregation of information for the river basin and sub units seems useful. Furthermore, a European wide visualization of the present situation, objectives or measures at sub unit level will provide a comparison of river basins and their problems and will give examples of how to deal with it. However, the necessary information to implement measures will have to be available for each water body at the level of water bodies, group of water bodies or other management units.

A catalogue of issues and questions that will be of use regarding an analysis and comparison of reporting data at European level and also for the compliance check could be compiled. Useful indicators to portray the situation in the river basin clearly would support the visualization. For instance, the PRBs supporting the Strategic Steering Group "WFD and Agriculture" have developed common indicators to comparably analyse the situation of agricultural pressures in European river basins and, furthermore, to show the effects of measures; this could serve as an example for other pressures.

III.9.5. Conclusions and recommendations

The impression is that the pilot exercise in the Ebro and Duero watershed has been different with respect with the same application in the Weser. The specific conclusion of the Ebro and Duero are reported in the section III.9.2.6. Due to the above mention differences, no common conclusion are shared with the Weser exercises.

About Phase II of the Pilot River Basin Activity

Since the adoption of the Water Framework Directive in 2000, a Common Implementation Strategy (CIS) was set up to guide its implementation. In a first phase a set of guidance documents were prepared, which were tested by the Pilot River basins. The outcome of this exercise is reported in the 2005 Pilot River Basin Outcome report. In the second phase – running from 2005-2006 and coinciding with the third CIS work programme - the Pilot River Basins have been involved in the different working groups and other activities set up in the CIS, and a wide variety of topics have been subject to pilot exercises. More information can be found on the European Commission's Directorate-General for the Environment Website:

http://ec.europa.eu/environment/water/index.html

The views expressed in this report do not necessarily reflect the views of the European Commission. The contents of this report has not been assessed by the Commission for compliance with the requirements of Directive 2000/60/60, and practices described in the report may therefore not necessarily be compliant with those provisions.

PART IV
AGRICULTURE

IV.1. INTRODUCTION

This report was prepared by the Rural, Water and Ecosystem Resources (RWER) of the Institute for Environment and Sustainability (IES) of the JRC based on the work performed and reported by the PRB-AGRICULTURE Group (see PRB list below). More information about these river basins can be found in chapter II or: http://ec.europa.eu/environment/water/water-framework/prbs.htm. The report addresses (one) specific aspect(s) of the common implementation strategy for the Water Framework Directive (Directive 2000/60/EC), as part of the second phase of a pilot basin river activity.

IV.1.1. PRB Background

Within the work programme of the Common Implementation Strategy of the WFD, and supported by PRBs during the first phase of the PRB exercise, the link between agriculture and water resources was identified as one of the highest priorities. It was considered important to discuss on how the Common Agricultural Policy can contribute to the achievements of the WFD objectives and provide guidance on how the authorities working on the WFD and the CAP can cooperate more closely. Therefore the 'Strategic Steering Group On Agriculture and WFD' was established at the same level as the Strategic Coordination Group in order to directly report to Water Directors and if requested to Rural Development Directors.

In support to the Strategic Steering Group on Agriculture, led during the 2005-2006 phase by UK and DG ENV, a network of 9 PRBs was coordinated by the Unit on Rural, Water and Ecosystem Resources (RWER) of the Institute for Environment and Sustainability (IES) of the JRC. PRBs participating in the Phase II and related to the SSG Agriculture are:

- ✓ Gascogne Rivers, France
- ✓ Guadalquivir, Spain
- ✓ Odense, Denmark
- ✓ Pandivere, Estonia
- ✓ Weser, Germany
- ✓ Zagya-Tarna, Hungary
- ✓ Ribble, UK (finished the PRB exercise in Oct 06 upon decision of the UK Government linked to the 'full implementation' of the WFD)
- ✓ Pinios, Greece (participated to the meetings but did not have an official PRB project running until the end of Phase II)
- ✓ Neisse, Germany (stepped out of the Group at an early stage)
- ✓ During the 16 months programme, the PRBs worked on the following specific areas:
- ✓ Assessment of the importance of pressures and impacts from agriculture on water resources
- ✓ Propose and report on planned, adopted or to be developed Programme of Measures

A separate report on the activities of this PRB-Agriculture Group is being prepared. This section is only an executive summary of the PRB-AG report.

IV.1.2. Introduction to agriculture pressures

During the last century, local subsistence, economic and population pressure, with changing dietary needs, and global markets have been driving important land use and agricultural management changes in rural Europe. Increase in Utilized Agriculture Area (UAA) along with intensification of agriculture in terms of space and inputs, are mainly responsible for significant pressures on the water resources and the water ecosystems in the European basins, including coastal waters.

The need for agricultural efficiency and productivity has resulted indeed in structural changes, including decrease in number of farms, less diversity of local agricultural habitats, reliance on non-renewable inputs as fertilizer and pesticides, cultivation of marginal land including land reclamation of wetlands, mechanisation, and increasing field size and higher stocking densities. Agricultural intensification, such as increased livestock production/density, the shift from hay to silage systems for grassland management, change in type and timing of tillage and e.g. the increased use of chemical inputs (fertilizers and pesticides), further led to increased pressures. Pressures include waterborne and airborne losses of nutrients and pesticides, and physical pressures caused by drainage, land reclamation, regulation of rivers and irrigation of farmland.

Understanding of the variations and dynamics in Utilized Agricultural Area (UAA) and changes in farming practices and the consequences of that to the different environmental aspects, including water resources, throughout Europe is therefore of prime importance for the sustainable management of the natural resources.

An earlier background paper produced by the SSG[15] based on information from the Article 5 reports, lists the main pressures. The PRBs work confirmed these and formed the main structure of their work and reporting. Keeping the European point of view and depending on the specific conditions in each river basin, the PRB-AG work came to a ranking and conclusions of the following problems:

1. Nutrient pollution
2. Pesticide pollution
3. Water Quantity (agricultural use)
4. Sediments in terms of erosion and Phosphorus leaching
5. Habitat loss and physical modifications

Based on analysis of these pressures within the Basins, designing and targeting of mitigation measures have been done. A resulting Open Catalogue of Measures is proposed.

Simultaneously to the implementation of the WFD, however, a process within the Common Agriculture Policy (CAP) was initiated, involving a shift from production focus to a broader rural development approach, including emphasis on the restoration and maintenance of environmental quality. In view of the need to improve the converging trajectory of the two policies these measures to be implemented by the agricultural community will need to be included in the CAP implementation, mainly through including them in the Rural Development Plans. Communication and collaboration between Water and Agricultural managers is therefore an issue.

Relevant requirements of the Water Framework Directive

(not exhaustive – links to, pressures and opportunities from agriculture were increasingly realized during evaluation of the Art. 5 reports)

….establishing a framework for Community action in the field of water policy

…*(16)* Further integration of protection and sustainable management of water into other Community policy areas such as energy, transport, agriculture, fisheries, regional policy and tourism is necessary. This Directive should provide a basis for a continued dialogue and for the development of strategies towards a further integration of policy areas. This Directive can also make an important contribution to other areas of cooperation between Member States, inter alia, the European spatial development perspective (ESDP).

(19) This Directive aims at maintaining and improving the aquatic environment in the Community. This purpose is primarily concerned with the quality of the waters concerned. Control of quantity is an ancillary element in securing good water quality and therefore measures on quantity, serving the objective of ensuring good quality, should also be established. …

(Article 1) *The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which*: (a) prevents further

[15] "WFD and Agriculture – Analysis of the Pressures and Impacts – Broaden the Problem's scope", prepared for the SSG by Ecologic and Warsaw Agricultural University, Versio n 6 2006 (http://forum.europa.eu.int/Public/irc/env/wfd/library?l=/framework_directive/thematic_documents/wfd_agriculture/pressures_version6/_EN_1.0_&a=d)

deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems; …

(Article 11) *Programme of measures: …* (h) for diffuse sources liable to cause pollution, measures to prevent or control the input of pollutants. Controls may take the form of a requirement for prior regulation, such as a prohibition on the entry of pollutants into water, prior authorisation or registration based on general binding rules where such a requirement is not otherwise provided for under Community legislation. These controls shall be periodically reviewed and, where necessary, updated;

IV.2. PRB CASE STUDIES

At the start of the PRB-AG Phase II work the idea was put forward to base the analysis of pressures and impact from agriculture on water resources and ecosystems on existing data and/or modelled output that would be represented as a common list of variables based on harmonized information. It was soon felt that due to the differences between the Basins, a common list of variables or indicators would not serve the purpose of profound impact analysis and harmonization. However, the structure and catalogue of variables were thought to represent a rather exhaustive collection of information needed when working on assessment of pressures and impacts from agriculture on water resources and therefore valuable to report on and to share with other RBs. A listing of the most common variables was compiled.

Within the timeframe at disposal during this Phase II and the efforts needed to conceive the main concepts for the work, it is clear that the PRBs could not study or apply every single aspect. Nevertheless, the analyses of the key pressure problems, along with the accompanying case studies, offered a first step in the consolidation of understanding the complexity of the relations agriculture-water in view of designing an adapted Programme of Measures (PoM) fulfilling the WFD objectives.

IV.2.1. Problem 1. Nutrient Pollution

Case studies provided by: Gascogne Rivers, Guadalquivir, Odense , Pandivere, Ribble , Weser.

Introduction

The effects of extended use of external resources as inorganic fertilisers, the application of organic fertilizer, such as slurry, and use of imported fodder for livestock is very conspicuous and causes nutrient losses. Nutrient pollution of surface water and groundwater, and consequent eutrophication, has been an increasing problem throughout EU since the mid-20th century. Although nitrogen fertilizer consumption dropped after its peak in the mid 80ies, general consumption and application rates are still high compared to mid 20th century. Furthermore, the retention times of nitrogen in soil and groundwater has to be taken into account when analysing the present state and the effects of mitigation measures.

In some areas, livestock production is of great importance for the magnitude of the agricultural environmental pressures. High livestock density means high nutrient pressures on water bodies and nature. Pressures being either as nutrients leached into the aquatic environment or as airborne emissions of ammonia deposited in nature and waters. The livestock production (milk, meat, eggs..) in EU has steadily been increasing during decades. The international analysis agencies expect a continued growth in livestock production in the EU, especially in the new EU countries. Increased production is potentially causing further increase of pressures on nature and waters.

During the last century, also the massive drainage and land reclamation of wetlands imply increased nutrient pressures on ecosystems.

Synthesis

The PRB experience shows that in all basins, agriculture is the main nutrients pressure (N and P). Easily around 70% of waterbodies in the basins are at risk of not meeting WFD objectives due to this. Groundwater bodies show high concentrations as do the surface waters that are threatened by eutrophication. The Weser states in 62 % of the basin area groundwater bodies at risk due to diffuse source pollution. Also lakes and especially coastal waters are affected by nutrient pressures although a declining trend in surface waters is prevalent. The Odense states that all coastal waters and 75% of the lakes are at risk due to nutrient pressures, and 96% of the rivers are at risk mainly due to physical pressures related to agricultural activities in river valleys. The Gascogne Rivers calculated N surpluses at 30-80kgN/ha/yr. The Odense calculates farmland N-surplus at 85 kg N/ha at field level and 110 kg N/ha at farm level including the ammonia evaporation from stables etc. Some basins, such as the Pandivere and the Guadalquivir are still at rather low thresholds of nitrate concentrations in surface or groundwater bodies, but the increasing trends in intense agriculture areas is at a high rate.

Irrigated agriculture applies fertilizers at rates as high as 200kg/ha. In Odense where irrigation of fields is less frequent, the application rate of N fertilizers is 165 kg N/ha. In the Guadalquivir, application rates have been increasing from non irrigated to irrigated areas up to 400% for some crops.

High livestock densities were reported to influence heavily the nutrient loadings in waterbodies in practically all basins. The Odense reported (a) the total amount of fertilizers used in catchment, (b) the animal density and (c) the lost retention capacity within the catchment due to drainage and land reclamation of wetlands as the three main indicators to consider when designing a PoM.

In most basins measures have been adequately formulated. These included reduced fertilizer norms, use of catch crop, re-establishment of wetlands and more efficient use of manure. As historical monitoring data was available, the Odense e.g. could set clear quantitative targets for designing these mitigation measures to be most cost effective. However, monitoring data is a bottleneck in most cases.

The exercise made clear that technical measures can be designed but if only of voluntary character the success is depending on voluntary involvement of farmers and measures might therefore not be sufficiently implemented. All PRBs stressed that information, training and advice of farmers is an important prerequisite for implementing the Programme of Measures. It is also recommended to combine economic analysis of measure with sociological studies.

IV.2.2. Problem 2. Pesticide Pollution

Case studies provided by: Gascogne Rivers, Guadalquivir, Ribble.

Introduction

In agriculture, pesticides are used as plant protection products. They are used to fight crop pests and reduce competition. Hence, they improve yields and the economic benefits for the farmers by providing security of production. As the CAP has been focusing on improving agricultural production, pesticides have become an increasing specific tool in this field. They are employed on a large scale and considered essential in modern cropping. Regulations are implemented for a long time in EU but certain pesticides can be detected in the environment.

Synthesis

Pesticide use is widespread in agriculture areas in all basins. Within the PRBs many water bodies are reported to be at risk of not meeting Water Framework Directive objectives due to pesticide pollution. The Gascogne Rivers report that all communes have priority status for implementing mitigation measures. Ribble indicates 16 water bodies at risk and the Guadalquivir found that water bodies in olive groves areas show high concentrations of many different pesticide substances. In many cases the individual thresholds of 0.8 ug/l were exceeded. Ribble reports that a number of water bodies are polluted, i.e. above drinking water standard of 0.1 ug/l ([16]), but that exact sources cannot be confirmed as similar active substances are also used in amenities and for home and garden. Analysis problems arose as adequate and/or comparable data was sometimes not available. Although the Gascogne Rivers composed maps indicating risk areas, the Guadalquivir states that consumption data is only available at provincial level and could not be disaggregated. Ribble says that limits of detection are variable and sampling frequency is low and that the vast majority of pesticides were recorded at the limit of detection while only the substances above the limit of detection were graphed or mapped.

Localized measures were applied in the Gascogne Rivers since 2001 and included measures that were introduced through the CAP Rural Development (RD) schemes. Equally the Guadalquivir indicates that the CAP RD green farming measure was used and showed to be successful in reducing chemical treatments by using the products more efficiently but still by guaranteeing sufficient crop protection. So far, Gascogne Rivers has partially assessed the

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[16] *the Drinking Water Standard is only applicable to groundwater and drinking water but recently this threshold is also applied in some cases for surface water at the point of abstraction for drinking water production. This clearly does not mean that the DWS applies to all SW bodies. (comment by ECPA)*

effects.

A variety of legislation is in place for mitigation, but it is recognized that current effects may result from bad management in the past and from past and present illegal use. This makes it more difficult to assess success of the recent efforts reducing PPP risk through improved management and application.

IV.2.3. Problem 3. Water Quantity (agricultural use)

Case studies provided by: Guadalquivir, Zagyva-Tarna

Introduction

In the Mediterranean area, roughly around 50% to 87% of water use relates to agricultural demands. Hence in order to reach the WFD objectives, proper and sustainable agricultural land management is needed. Notwithstanding the technology improvements to irrigation systems and application, the continued increase in irrigation area by including extensions to traditionally non irrigated crops such as olive trees and the introduction of crop species less adapted to the Mediterranean climate, are responsible for the unsustainable pressure coming from agricultural water use.Then again, water quantity stress is not exclusive for the Mediterranean only. The Hungarian Zagyva-Tarna provides a case study on this as well. Furthermore one can argue that in view of the above mentioned pollution problems, the available quantity of readably useable water for e.g. drinking consumption is increasingly getting reduced, however no case studies were provided further on this aspect.

Synthesis

Within the two case study basins, irrigation is the main pressure on water quantity. In the Guadalquivir the water consumption by agriculture (86%) and livestock (1%) are well above the needs of the domestic, industrial and tourism sector which together account for the remaining 13% (tourism less than 1%). Also the Zagyva-Tarna suffers from over-extraction for agricultural purposes and estimated that half the surface bodies are at risk, as are most of the lower sections of the basins. Furthermore in several groundwater bodies abstraction is nearly twice the recharge capacity. Although, groundwater abstraction amounts to 82.7% for agricultural use in the Guadalquivir, more than 50 % of the total regulated surface volume is held in reservoirs whose main objective is agricultural use. Hence a hydrologic regime pressure indicator was developed, being the reservoir capacity versus the average annual natural inflow. This indicator showed a global value of 103,7% and extreme pressure values higher than 420%.

There is a large experience in measures related to irrigation infrastructure and watering techniques, but still uptake and implementation by farmers is behind. However since the implementation of the WFD in the Guadalquivir some milestones have been reached related to improvement of policies, review of hydrological plans, new water agreements and infrastructure works. The Zagyva-Tarna envisage possibility for reduction in irrigation areas on consider trans basins water transfers as an option. Problems remain the uncontrolled increase in water demand which are difficultly satisfied and lack of involvement of all stakeholders in the processes.

IV.2.4. Problem 4. Sediments in terms of erosion and Phosphorus leaching

Case studies provided by: Guadalquivir, Odense

Introduction

The general effect of erosion is a reduction of natural soil fertility that in itself causes an increased need for input, and a stimulated transfer of nutrients, pesticides and sediments into surface waters.

More intensive agriculture often stimulates increased erosion affecting the soil structure. Some farming practices reduce the amount and continuity of green cover enhancing the risk to soil erosion. This is an EU wide problem although Mediterranean areas are very vulnerable due to the climatic characteristics.

Soil erosion facilitates the delivery of contaminants to water resources. Phosporus (P) is sparse in soils and easily sticks to soil particles as water moves through the soil. Increased agricultural inputs of P augmented P concentrations in surface waters mainly through increased run-off and P brought in by soil particles through direct erosion or by preferential flow through macro-pores from the P rich top soils to the drainage systems.

Synthesis

Within the Guadalquivir basin, high levels of soil loss and land use could be related, especially for olive grove areas. Other land and agricultural management practices, such as removal of protective green cover and excessive tillage, were found to be indicative for increased erosion risks. For relating suspended solids to erosion potential however, the reservoir effect had to be modeled, but correlations were not always indicative enough to indicate target areas for mitigation measures. Within the Odense, diffuse phosporus losses from the river basin constitute 76% of total P input in the estuary. Agriculture was found to be responsible for 60% of the diffuse losses. In fact, phosphorus inputs from agriculture to surface waters mainly come from the following sources: soil erosion, in-river erosion of river banks that are enriched in P due to adjacent cultivation, artificial drainage systems on loamy soils with macropores, and artificial drainage systems on organogenic soils with a low P binding capacity. The soil P content and the fertilizer application rate/surplus in combination with P loss pathways determine the magnitude of the P loss.

To make measures cost effective they must be optimally targeted. The Odense examined the P Index as possible method for identifying and ranking risk areas. The index was found to be able to describe the factors that cumulatively determine the P losses to surface waters, but needs further testing. Agri-environmental measures in the RD plans are thought to be effective but more farmer involvement is needed to increase uptake and implementation. These case studies enhanced again the complexity of the cause-effect relation between the suspected driving force, agriculture, and the status, being water quality.

IV.2.5. Problem 5. Habitat loss and physical modifications

Case studies provided by: Guadalquivir, Odense, Ribble

Introduction

Many of the aspects of hydrological alterations are being covered in chapter III of this document. There it was also stated that changes to river's morphology also occurred related to or for agricultural purposes. The PRB-Agriculture did not cover the river morphological changes as such, but focused on the changed longitudinal, transversal or other changed river characteristics related to agricultural activities. These include the alteration and status of the riparian areas and the effects of agricultural land reclamations on reducing the area of water surfaces and wetlands. Apart from hydrological consequences, these changes can result in considerable structural and polluting impacts on natural ecosystems and hence flora and fauna habitats.

Synthesis

In the Ribble basin monitoring and analysis of the riparian status was done prior to the WFD, hence was not designed to address the status as required by the WFD. However, as in the Guadalquivir basin, the riparian status shows a direct relation with the extent and degree of intensity of agricultural management along the river. Agriculture is responsible of the occupation of wide stretches of riparian areas and severely impacts on their status. It was also noted though that agriculture is maybe not the main source of status decrease when considering the total length of the river. Population pressure and abandonment of traditional (river bank) management were indicated as other sources. In the Ribble basin from the observed water bodies 34% were in good riparian status while 53% were in bad status. When looking at sub basin level in the Guadalquivir, the areas with indication of low status are in the intense agriculture areas. Again further detailed cause-effect analysis is needed. The effectiveness of mitigation measures was found better in areas where green farming and/or erosion control was introduced; areas under integrated rice production did not show differences. Detailed mitigation measures exist in the Ribble but no effectiveness data was given. Maintaining riparian status is needed as it exerts an important buffer capacity for leaching, erosion and prevent pesticide drift during application.

In the Odense, more than a third of the surface area of the Fjord was reduced by land reclamation since 1780. More than 70% of major wetlands (mires, meadows etc) in the catchment have been lost to agriculture, meaning a loss in habitats. Dyking, drainage, regulation and straightening of rivers and river maintenance are the more destructive modifications causing increased physical pressures of especially rivers. All these interventions imply that the wetland buffer capacity has been lost, hence the pressure from nutrients on surface waters is further enhanced.

IV.3. COMMON LESSONS LEARNED

The PRB exercise increased exchange of information on methods and approaches for performing analysis of pressures and impact from agriculture and was conceived as a positive output. However, it was felt that, during the phase of full implementation of the WFD, more networking would increasingly inspire the process of compiling RBMP.

PRB related activities such as the meeting preparation and the reporting were sometimes seen as extra burden and compromised management and planning work.

In many PRBs the practical possibilities of performing the data collection and analysis and compiling adapted PoM were lacking in terms of time and required funds, although most PRBs clearly indicated the added-value of the common exercise.

IV.4. CONCLUSIONS AND RECOMMENDATIONS

Agriculture is responsible for main pressures on water resources, related to nutrients, pesticides, water quantity, erosion and habitat loss. However the cause-effect patterns remain very complex, these pressures can now be better identified and sometimes this can be used for better targeting mitigation measures. Hence, agriculture also has the enormous potential for improving general environmental conditions in the basins.

The analysis exercises pointed out that in many cases critical information and data is not systematically collected and therefore, planning of data monitoring schemes is of importance. The PRB-AG therefore documents a framework of indicators meant for guidance and harmonization of data requirements.

There is or would be enough knowledge to design technical measures, although quantifying targets remains difficult in fields like erosion or habitat loss. Implementation of measures remains site-specific and final effectiveness will depend on the farmers uptake. Awareness in this stakeholder group has to be actively raised. An open Catalogue of Measures is proposed.

The coordination between water management and agricultural policies is an important issue especially with respect to the design of funding programmes. At local level co-operation models and local action group are increasing the cooperation of farmers and water management. Further exchange of experience and exploring new approaches are necessary.

The report of the PRB-Agriculture group proposes a first version of an open-ended Catalogue of Measures and contains a list of measures already defined within the PRBs.

The PRB-AG all indicated that there is need to continue with the group as more exchange on good examples of measures and implementation will be needed during the short phase towards RBMPs.

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About Phase II of the Pilot River Basin Activity

Since the adoption of the Water Framework Directive in 2000, a Common Implementation Strategy (CIS) was set up to guide its implementation. In a first phase a set of guidance documents were prepared, which were tested by the Pilot River basins. The outcome of this exercise is reported in the 2005 Pilot River Basin Outcome report. In the second phase – running from 2005-2006 and coinciding with the third CIS work programme - the Pilot River Basins have been involved in the different working groups and other activities set up in the CIS, and a wide variety of topics have been subject to pilot exercises. More information can be found on the European Commission's Directorate-General for the Environment Website:

http://ec.europa.eu/environment/water/index.html

The views expressed in this report do not necessarily reflect the views of the European Commission. The contents of this report has not been assessed by the Commission for compliance with the requirements of Directive 2000/60/60, and practices described in the report may therefore not necessarily be compliant with those provisions.

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Abstract

Building on the successful work of the first phase (2002-2004), the Pilot River Basins (PRBs) have continued to work closely also in the second phase (2005-2006) within the Common Implementation Strategy of the Water Framework Directive (WFD).

The objectives of Phase II of the PRB exercise were:

- to provide concrete input and case studies to all CIS activities and to address questions on so-called "key areas", as identified by the respective Working Groups;

- to present examples and ideas for key elements of the WFD implementation, ahead of the deadlines required by the Directive;

- to create networks and promote activities with other interested partners on subjects not (yet) identified as key areas under the Common Implementation Strategy.

The key areas are all the activities agreed in the CIS Work Program 2005 2006, including subjects dealt with by the five Working Groups and the Strategic Steering Group on "WFD and Agriculture".

This report comprises of four sections: part 1 is the introductory section, providing the background and rationale; part 2 includes the descriptions of all PRBs participating to the activities described in part 3; part 4 provides a summary of the activities and findings of PRBs collaborating with the Strategic Steering Group "WFD and Agriculture".

This report, as well as the full PRB group on agriculture titled "Experiences in Analysis of Pressures and Impacts from Agriculture on Water Resources and Developing a Related Programme of Measures" are available at http://ec.europa.eu/environment/water/water-framework/prbs.htm

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