AquaSoilSAGE

Service for the Provision of Advanced Geo-Information on Environmental Pressure and State

POLICY REVIEW

ESA-GSE Project on

Water Framework Directive and Soil Thematic Strategy

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EXECUTIVE SUMMARY

Policy makers are increasingly in need of accurate and timely information in order to meet reporting requirements linked to environmental legislation. This paper explores the extent to which Earth Observation (EO) services can help to meet the special reporting requirements of two major European Union (EU) environmental policy areas, namely the Water Framework Directive (WFD) and the Soil Protection Initiative (SPI).

The Water Framework Directive

A large number of monitoring and reporting obligations are anchored in the WFD. The WFD identifies the need to monitor the water status on a systematic and comparable basis throughout the Community. In its requirements, it does not foresee any special monitoring methods. The monitoring system simply has to "ensure the establishment of programmes for the monitoring of water status in order to establish a coherent and comprehensive overview of water status within each River Basin District".[1] In order to unambiguously evaluate the water quality, a corollary to this requirement is the need for comparability between results obtained not only by different laboratories but also at different times or places. Furthermore, the shift in the focus of water management from water bodies to river basins implies that monitoring techniques have to move from the "classical" one point consideration to an area-oriented approach.

The report comes to the conclusion that EO services can provide answers to a number of these newly emerging monitoring issues. Although it is certainly not applicable to all monitoring requirements of the WFD, EO has the potential to provide some parameters with greater accuracy over large areas and is capable of reducing overall costs for data sampling and monitoring. Furthermore, EO could also provide a common monitoring standard to which all Member States would adhere at the same costs, ensuring the comparability of results and the coherence of monitoring and evaluation methods employed. Within the Common Implementation Strategy (CIS) Guidance Document on Monitoring, EO tools are currently mentioned for two parameters in the list of quality elements only. However, as the CIS process is still dynamic, it may offer considerable chances for EO services, for example in relation to the WFD requirements on cost-effectiveness and comparability.

The Soil Protection Initiative

In 2002, the 6th Environmental Action Programme (EAP) of the European Union was adopted, which identifies soil as a non renewable resource under pressure and sets out the objective to protect soil as a natural system in general and specifically against erosion and pollution. The programme proposes a "Thematic Strategy for Soil Protection" to be produced by 2004. At the beginning of 2002, the European Commission published a communication "Towards a Thematic Strategy for Soil Protection"[2] that outlines the potential scope of such a strategy and constitutes the first document from the Commission that deals comprehensively with soil protection.

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1 Article 8 Water Framework Directive.

2 European Parliament and Council 2002: *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.* Published in OJ L 242 of 10/9/2002.

Besides the Soil Protection Initiative, the European Spatial Development Perspective (ESDP), adopted in May 1999, is also presented, as it is one of the major policies that will have a major impact on the issue of soil protection in the future. The purpose of this initiative is to add a spatial dimension to European regional policy and to define at the Union level policy objectives and general principles of spatial development, while respecting its diversity.

While there is a common understanding in Europe of the need for soil protection, national soil legislation differs significantly among EU Member States. The legal basis on the national level often does not relate to the soil medium directly, but rather is linked to air or water issues. At the individual country level, widely differing types of administration co-exist at the regional or municipal level. National soil monitoring programmes, albeit designed for different purposes, have already been implemented in some countries and are under consideration in many others.

One of the major problems for the assessment of soil condition in Europe, based on existing data, is the lack of harmonised methodologies for monitoring and data transfer, leading to a lack of comparability of data. EO services could contribute to a harmonised data collection and offer large benefits by delivering comparable data in a timely and cost-effective way.

Implementation Status

The policies discussed above - the Soil Protection Initiative and the Water Framework Directive - are still in the development or implementation stages respectively, and thus still offer sufficient integrating scope for Earth Observation.

The implementation process of the WFD is still being elaborated and is constantly under review, whereas many elements of the SPI are still in their infancy. While the indicators and the parameters for measuring the status of water are almost completely outlined, the choice of indicators according to soil are not yet finalised. Information requirements are also still highly undefined. But even in the WFD there are gaps that have to be filled, especially on the issue of establishing appropriate monitoring programs. This presents a chance to expand application of EO data in the context of these policies.

Other policies of importance

Apart from the WFD and the Soil Protection Initiative, there are other EU policies which might be relevant in the Global Monitoring for Environment and Security (GMES) context. In particular, information and reporting policies are likely to increase information flows and data requirements and might thus enhance the demand for EO products. They are presented briefly in *Chapter 9*.

- The most influential document with respect to public participation in the area of the environment on the international level is the Aarhus Convention.[3] This Convention acknowledges that protection of the environment and sustainable development cannot be achieved without the involvement of a well-informed public. It endows citizens with the rights of access to information, public participation in decision-making and access to jus-

[3] United Nations Economic Commission for Europe (UNECE) 1998: *Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters*. Aarhus, Denmark, 25 June 1998.

tice in environmental matters, thus promoting "environmental democracy". Public authorities are required by the Convention to make environmental information available to the public upon request (Article 4, (1)).

- The Standardised Reporting Directive (enacted in 1991) has been criticised by the European Parliament as having failed to achieve its goals, and new rules on environmental reporting have been called for. Currently, a proposal for an amendment to the 1991 Directive is being discussed by the European Commission and the Member States; its final adoption is expected for 2004. The new Directive will introduce a standard reporting mechanism for all environmental legislation, and it is expected to cover three types of reporting: check on compliance, policy evaluation and state of the environment. While it remains to be seen how specifically the data requirements will be defined in the new legislation, it is likely to entail a greater need in the Member States for reliable data and continuous monitoring of the environment, and might well increase the EU's reliance on Earth Observation.
- INSPIRE (Infrastructure for Spatial Information in Europe) is a recent initiative launched by the European Commission. The key objective of INSPIRE is to make more and better spatial (geographical) information available for Community policy-making and implementation in a wide range of sectors, starting with environmental policy. INSPIRE focuses specifically on information needed to monitor and improve the state of the environment, including air, water, soil, and natural landscape. EO data and services could play a major role in this process, especially in the issues of harmonising data and generating common standards.
- Within the EU, there is a wide range of other policies addressing environmental issues that could be of further interest for EO services, for example, the Common Agricultural Policy (CAP) and the Natural Habitats Directive. Both policies outline the needs for environmental data, often very similar or strongly related to one other (e.g. data on land use, land cover), which might well enhance the demand for EO services.

Conclusions

The main conclusion of this report is that EO services offer significant potential benefits to policy implementation processes and may further the implementation of the WFD as well as provide key input for the further formulation of Community legislation on soil. A key issue emerging from the analysis is that in order to convince policy-makers to integrate EO to a greater extent as a solution for information requirements in the policy implementation documents, it is important to raise awareness by providing sound information on the benefits of EO. It needs to be shown in which cases the advantages of EO, such as its potential for spatial coverage and data standardisation, will outweigh the costs in the short and long term.

In order to promote the use of EO data in water policy, the WFD Common Implementation Strategy process should be monitored, and possibilities for EO applications should be identified. In the context of the SPI, a great potential for EO lies in the still open discussion on relevant indicators and the final definition of information requirements. The introduction of the possibilities of EO services into the new Working Groups established to further develop the SPI in the future also has a great potential.

Service providers can contribute to increased co-operation with policy-makers by following the policy processes, anticipating future needs at early stages, and by linking the develop-

ment of services to the progress and requirements of policies, especially with regard to reporting requirements, monitoring and standardisation.

1 SCOPE OF THE STUDY

As part of the SAGE project, this policy review investigates the potential of EO services to support the implementation of two important European environmental policy areas, namely the Water Framework Directive and the Soil Protection Initiative. This review provides the political context along with the current status of implementation of the two policies and outlines their key information requirements. The report analyses how these information requirements are met today, and to which extent there is potential for EO to enhance the policy implementation by providing better results.

As a consequence of the different legislative status of the two policies, the analysis cannot be applied in the same way to both the WFD and the SPI: While the implementation of the WFD can be translated from the EU-wide level to the single SAGE member countries and other Member States, this is only minimally possible for the SPI, as it has only a strategic character with no legal requirements currently linked to it. Furthermore, the published information base available for the SPI at the European level is far less developed than that for the WFD, which is currently high on the political agenda of all European Member States due to the upcoming reporting deadlines.

In addition to the two central policy areas, this report also addresses in its analysis a number of European policies that aim to further public information and participation. The notion of *public participation* - obligations to provide information to the public and the right of the public to access information on environmental matters - has been increasing in importance, marking an interesting development in European environmental policy. In light of the fact that EO has the potential to facilitate greater involvement of the public, these policies have been included to complement the analysis of EO potential to meet legislative requirements.

2 BACKGROUND AND INTRODUCTION

For decision-makers at the national and European level, there is an increasing demand for timely information and data provision that is tailored to meet specific environmental reporting requirements. The SAGE project focuses on supporting the implementation of two important European environmental policy areas, namely the Water Framework Directive (WFD) and the Soil Protection Initiative (SPI). This policy review introduces the necessary political background by clarifying key information requirements resulting from these two policies which can be met with Earth Observation (EO).

In the overall SAGE project, the policy review is intended to provide input to the service prospectus.

2.1 APPLIED METHODOLOGIES

This report has been compiled through consultation and interviews with the relevant experts at the European and national level, a review of the available literature as well as through the integration of recent conference proceedings.

2.2 STRUCTURE OF THIS REVIEW

The report has been structured as follows: Chapter 5 outlines some general issues related to environmental information requirements at the different administrative and reporting levels.

Chapter 6 introduces the general policy background of the European Water Framework Directive and outlines its present status of implementation at the EU level as well as in selected ESA Member States. Furthermore, the present data availability and the current use of EO are addressed. Finally, the Directive's monitoring and reporting requirements are presented (which are further detailed in an extensive Annex).

Chapter 7 gives an overview on the second policy area covered in the SAGE project, namely the Soil Protection Initiative. The general policy background is presented along with the present state of play. Because the SPI has merely a strategic character, it is not possible to present exact information "requirements". Nevertheless, the present status of discussion on possible indicators will be reviewed and the resulting possible uses of EO outlined.

Chapter 8 then turns to presenting current EU policies that address the issue of public participation and discusses possible interconnections with EO. Finally, Chapter 9 presents a synthesis of environmental Earth Observations, while Chapter 10 focuses on preliminary future options and recommendations for the interface of environmental reporting and EO.

3 GENERAL ISSUES ON INFORMATION REQUIREMENTS

Over a span of almost 30 years, reporting procedures have been developed to provide the Commission with information relating to the implementation of its legislation. While some legislative requirements deal with reporting on the state of the environment, others are concerned with the extent to which the legislation has achieved its objectives, resulting in different information and reporting obligations.[4]

In response to legislative requirements, thousands of files, databases, and data warehouses have been developed by states and local government agencies, constituting an expensive and valuable resource. Over the years, the systems available for managing collected information and data have been widely extended (e.g. development of computer systems, the internet, GIS etc.). Nevertheless, the problem of incompatible and duplicate information has not been reduced by this development, and sharing or integrating information or data from different sources constitutes one major difficulty. As data requirements differ by users and by field of application, collected data need to be processed differently and often individually to match the respective demands. Accordingly, a "one fits all solution" can in many cases not be made available and solutions designed for individual purposes must be provided.

The reporting requirements of a directive may, for example, create inhomogeneous data needs along the different levels of administrative and legal authorities. For reporting at a local level, more detailed data and information are often required because the main focus is on the local environmental status and local planning issues.[5] On a more aggregated level, EU legislation requires Member States to report on their compliance with the terms set out in the legislative texts, in order to assess whether environmental policies are achieving their goals or not and to evaluate potential impacts of new policies. The 6th Environmental Action Programme (6EAP), for example, identifies the need to undertake "ex ante" evaluation of possible impacts of new policies (with a special emphasis on environmental impacts) and "ex post" evaluation of the effectiveness of existing measures in meeting their intended environmental objectives. In other words, it recognises the need to review and regularly monitor information and reporting systems with a view to establishing a more coherent and effective system and to ensure streamlined reporting of high quality, and the generation of comparable and relevant environmental data and information.[6]

The development of a common Data and Information Management System (DIMS) - as planned by the Commission - will not be easy with many issues to be resolved, but it can still be a chance for implementing EO services.

Having outlined a number of general points for consideration on information requirements for the upcoming analysis, the following chapter investigates in how far earth observation has

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4 European Environment Agency (EEA) 2001e: *Reporting on environmental measures - Towards more 'sound and effective' EU environmental policies.* Environmental issue report No. 25, prepared by: Sofia Guedes Vaz, Jock Martin, EEA, and David Wilkinson, Jodi Newcombe, IEEP. Copenhagen.

5 Different user requirements at the different administrative levels will also affect EO service providers. As the analysis of user needs shows, the level of resolution requested for implementing the Water Framework Directive displays a high degree of variability, ranging from 5 m to 5 ha.

6 Decision No. 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environmental Action Programme was published in Official Journal L 242 of 10/9/2002. For more information see: http://www.europa.eu.int/comm/environment/newprg/index.htm.

the potential to mitigate these negative effects in relation to the WFD and the SPI respectively and to facilitate an integrated approach in meeting the policies' specific information requirements.

4 SELECTED POLICY AREA: THE WATER FRAMEWORK DIRECTIVE (WFD)

4.1 POLITICAL CONTEXT AND POLICY IMPLEMENTATION STATUS

The evolution of European water policy is marked by three distinct waves.[7] The first wave started with the initiation of the first of a series of five-year Environmental Action Programmes (EAP) in 1973, laying down the objectives and principles of the environmental policies of the European Commission (EC).[8] Since the end of the 1970s, several measures for the reduction and prevention of water pollution have been introduced in a number of Directives, based primarily on a regulatory approach.[9] The basis for these first legal acts with the intention of protecting water was the original EC Treaty[10] which at the time needed a specific title for the environment.

The Directives subdivided the aquatic eco-systems into individual protected commodities and defined quality targets, each of which had to be followed or achieved through certain measures.[11]

In 1990 the major problems of water pollution within the EU were seen in the increasing eutrophication of sea and fish waters and in the general state of water resources. As a result of this, two new legal instruments were adopted setting strict rules on the treatment of wastewater and the use of nitrates in agriculture; this was the second wave in the evolution of European water policy. Wastewater treatment became obligatory even in the smallest settlement and legally binding measures came into force which limited the amount of animal fertiliser used on fields. With the implementation of the Directive concerning integrated pollution prevention and control (96/61/EC), a new rule for emissions control was formulated. Also, the guideline to control the dangers in the event of major accidents (96/82/EEC, the so-called Seveso II Directive) contains important aspects of water protection. However, in spite of the numerous regulatory interventions on the Community level, criticism about the lack of consistency in water protection policy continued.

A communication of the European Commission on the water policy of the Community in February 1996 marked the start of the third wave in European water policy.[12] In this document the European Commission concluded that a Water Framework Directive should be drawn up

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7 Austrian Federal Ministry for Agriculture and Forestry, Environment and Water Management 2000: *EU launches new water policy*. Aqua press international, 5/2000.

8 In the following EAP, the EC stressed the growing importance of environmental policies. The fourth programme emphasised that environmental concerns need to be taken into account in the entire corpus of EC policies; the fifth programme "Towards sustainability" makes environmental protection alongside social and economic concerns an integral and equally important element in making decisions.

9 Directives of the first generation are: Surface water directive (75/440/EEC), Bathing water directive (76/160/EEC), Fish water directive (78/659/EEC), Shellfish water directive (79/923/EEC) and Drinking water directive (80/778/EEC).

10 At this time a unanimous decision was still a prerequisite for the enactment of secondary Community law in the Council of Ministers.

11 Holtmeier, E-L. 1997: Development of European Water Legislation, in: Ministry for Environment, Spatial Planning and Agriculture of North Rhine-Westphalia (ed.): *Environmental Protection in Europe as well as on the Federal and State Level - Conference Proceedings*.

12 Communication from the Commission 1996: European Community Water Policy, COM(96) 59 final Brussels: European Commission.

in order to concentrate, rationalise and standardise, as well as improve the efficiency of European water protection legislation.[13] The new Water Framework Directive was adopted and finally entered into force in December 2000.[14] As opposed to the water protection of the 1990s, the area covered by this Directive extends to all aquatic systems, surface waters (rivers and lakes), groundwater and coastal waters. Land eco-systems depending on groundwater are also included in the protection of the quantity of groundwater. Therefore water resources should be managed across national boundaries, choosing a co-ordinated approach within the river catchment areas. It further bundles the approaches from the first and second wave to form a coherent overall concept and abolishes some of the individual directives. Within thirteen years the WFD will replace most existing water legislation:[15]

The main target of this Directive is to achieve the "good status" of all surface, ground and costal waters[16] in the Community by 2015 whereby there is a differentiation between the ecological and chemical status of water. The basic thinking behind the term "*good ecological status*" is that water can be used by humans as long as the ecological function of the water body is not significantly impaired. The ecological function is defined by requirements for the different types of water by the EU. It still has not been specified how to define good ecological quality and how to carry out the assessment of water. The *chemical water status* is to be determined by environmental quality standards for hazardous substances.

In November 2001, the European Commission established a list of priority substances in the field of water policy.[17] The list identifies 33 substances or groups of substances which have shown to be of major concern for European Waters. The list will be reviewed and adapted by

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13 Communication from the Commission 1996: European Community Water Policy, COM(96) 59 final Brussels: European Commission.

14 The European Parliament and the Council 2000: *Directive of the European Parliament and of the Council concerning establishing a framework for community action in the field of water policy* (2000/60/EC), 23 October 2000.

15 In 2013 there will only be the following Directives in the European Community left, which contribute to a major part that clean water in sufficient quantity becomes a reality all over Europe: Urban Waste Water Treatment Directive (91/271/EEC); Discharges of Dangerous Substances Directive (76/464/EEC) and the Priority Substances under the Water Framework Directive; Nitrates Directive (91/676/EEC); Bathing Water Quality Directive (Council Directive 76/160/EEC concerning the quality of bathing water) and its proposed revision; Drinking Water Directive (98/83/EC). For further information see http://europa.eu.int/scadplus/leg/en/lvb/l28002b.htm.

16 Until now no clear definition of the term "good status" is available. The CIS Guidance Document is expected by mid 2003. The term "good status" of water has to be split into "good surface water status" and "good groundwater status". "Good surface water status" means the status achieved by a surface water body when both its ecological status (classified in accordance with Annex V of the WFD) and its chemical status are at least "good". "Good surface water chemical status" means the chemical status required to meet the environmental objectives for surface waters established in Article 4(1)(a), that is the chemical status achieved by a body of surface water in which concentrations of pollutants do not exceed the environmental quality standards established in Annex IX and under Article 16(7) of the WFD, and under other relevant Community legislation setting environmental quality standards at Community level. "Good groundwater status" means the status achieved by a groundwater body when both its quantitative status (defined in table 2.1.2 of Annex V of the WFD) and its chemical status (see table 2.3.2 of Annex V of the WFD) are at least "good".

17 European Parliament and Council 2001: *Decision No. 2455/2001/EC, Decision No. 1600/2002/EC of the European Parliament and of the Council of 20 November 2001 establishing the list of priority substances in the field of water policy and amending Directive 2000/60/EC.* Published in Official Journal L 331, 15/12/2001.

the European Commission four years - at the latest - after the entry into force of the Water Framework Directive, and then at least every four years thereafter.

Another key point of the Directive is the combination of an emission related approach with discharge related measures to reduce pollution under the basic obligation of cost recovery (Article 9).

The WFD suggests four main fields of action:

- Development of principles for integrated planning and management of waters;
- Implementation of regulations concerning the quantitative protection of water resources;
- Establishment of instruments to control groundwater pollution by non-point sources; and,
- Implementation of instruments to control groundwater pollution by point sources.

4.2 COMMON IMPLEMENTATION STRATEGY (CIS) FOR EUROPE

The Water Framework Directive includes an exact plan of implementation in the Member States, setting out clear deadlines for each of the requirements which adds up to an ambitious overall timetable. The key milestones are listed below (Table 1):

Table 1: Timetable for the Implementation of the EU Water Framework Directive

Year	Issue	Reference
2000	Directive entered into force	Art. 25
2003	Transposition in national legislation	Art. 23
	Identification of River Basin Districts and Authorities	Art. 3
2004	Characterisation of river basin: pressures, impacts and economic analysis	Art. 5
2006	Establishment of monitoring network	Art. 8
	Start public consultation (at the latest)	Art. 14
2008	Present draft river basin management plan	Art. 13
2009	Finalise river basin management plan, including programme of measures	Art. 13 & 11
2010	Introduce pricing policies	Art. 9
2012	Make operational programmes of measures	Art. 11
2015	Meet environmental objectives	Art. 4
2021	First management cycle ends	Art. 4 & 13
2027	Second management cycle ends, final deadline for meeting objectives	Art. 4 & 13

During the implementation process, a number of shared technical challenges for the Member States, the Commission, the Candidate Countries and other stakeholders will arise. In addition, many of the European river basins are international, crossing administrative and territorial borders, which makes a common understanding and approach crucial to the successful and effective implementation of the Directive. In order to address the challenges in a co-operative and co-ordinated way, the Member States, Norway and the Commission agreed on a Common Implementation Strategy (CIS) for the Water Framework Directive only five months after the Directive's entry into force. The key activities of this strategy are:

- Information sharing;
- Developing guidance on technical issues;

- Information and data management; and
- Application, testing and validation.

The strategy could be divided in three phases:

- Phase I: Preparation of Guidance Documents (2001/2002);
- Phase II: Testing of Guidance Documents in pilot river basins (2003/2004); and
- Phase III: Manual for integrating river basin management (2004/2005).

In the first phase that ended early in 2003, the EU Commission set up various working groups which should draft practical Guidance Documents to assist in the implementation process. More than 500 experts from Member States, Candidate Countries, stakeholders, environmental NGOs, EU institutions and EU research projects are actively involved in the CIS work. The developed guidelines are not of a compulsory character for Member States but should rather be considered as recommendations.[18]

For the second phase, the Water Directors of the European Union, Norway, Switzerland and Accession Countries agreed in Copenhagen on 21 - 22 November 2002 to combine particular subjects into thematic groups so that each Working Group (WG) would have a rolling programme of linked works. Four themes at the working level have been identified:

- WG 2.A - Ecological Status;
- WG 2.B - Integrated River Basin Management;
- WG 2.C - Groundwater; and,
- WG 2.D - Reporting.

These 4 groups are led by the Strategic Co-ordination Group (SCG) carrying out the following work in 2003/2004:[19]

- Carrying out the pilot testing exercise comprised of the testing of the Guidance Documents in 14 pilot river basins all over Europe;
- Facilitating the intercalibration;
- Developing technical guidance on specific outstanding or new issues;
- Addressing economical methodological aspects;
- Maintaining the network;
- Linking the Expert Advisory Fora to the Common Implementation Strategy; and,
- Reviewing the Guidance Documents for inclusion in a comprehensive "EU Manual for Integrated River Basin Management".

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[18] Common Implementation Strategy Group 2001: *Strategic Document: Common Strategy on the Implementation of the Water Framework Directive*. May 2001, available at http://www.fcihs.org/INFO/DMA/strategy.pdf.

[19] Workshop held on the occasion of the Council meeting of the European Water Association (EWA) on 23 May 2003 in Lucerne, Switzerland.

4.3 NATIONAL IMPLEMENTATION STATUS IN SELECTED EUROPEAN COUNTRIES

4.3.1 Germany

4.3.1.1 Implementation Status and Identification of River Basin Districts and Authorities

In Germany, the implementation of the WFD is carried out at different administrative levels with different responsibilities.

Table 2: uthorities Involved in the Implementation Process of the WFD in Germany

Authority involved	Responsibility
1. Federal Government	- basic law, international co-operation
2. States	- execution
3. LAWA (Joint Water Commission of the States)	- co-ordination between the States
4. Working groups	- working out technical standards/documents for the handbook of technical implementation

As Table 2 shows, the Federal Government, as well as the German Federal States (*Länder*), are responsible for the implementation of the Directive.

The federal level only has the right to enact general provisions like setting a frame for water management. The seventh amendment of the Federal Water Act entered into force 25 June 2002.[20] It transposed the main aspects of the WFD into federal national law (ecosystem approach, obligation to co-operate and co-ordinate, objectives of the WFD for surface waters and groundwater, the WFD instruments (programme of measures and management plan)). It also defines ten River Basin Districts. In Germany there are ten river basin districts, most of them are transboundary, i.e. international river basins. The assignment of smaller parts of each district into sub-basins or sub-districts will be decided on and organised by the sixteen *Länder*, as they have the principal competencies for water management.

Based on a model ordinance the important Annexes II and V of the WFD will be implemented in the *Länder*. In addition to acts and ordinances and written instructions of no legal quality for the drawing up of the river basin, management plans are elaborated similar to the Guidance Documents. In those cases where the river basin district stretches through several *Länder*, the environmental ministries of these *Länder* are expected to co-operate and co-ordinate their activities. For this purpose co-ordination groups are established. Furthermore, a number of pilot studies and projects have been initiated in order to test and support the implementation process. On the European and international level, the Federal Environment Ministry represents Germany, again in close contact with the *Länder*.

The Joint Water Commission of the States (LAWA) aims at formulating solutions and putting forward recommendations for the handling of issues arising in the areas of water management and water legislation. The results obtained so far from this work are laid down in the

[20] Gesetz zur Ordnung des Wasserhaushalts (Wasserhaushaltsgesetz - WHG). BGBl. I S. 3245, 19 August 2002.

Handlungsanleitung,[21] the German implementation Guidance Document, which forms the basis for the implementation of a standardised water management system within the *Länder*.

Under the direction of the LAWA-EU Liaison Committee, two sub-committees were set up to perform the legal and technical functions associated with preparations for the implementation of the EU Water Framework Directive in Germany. These subcommittees collaborate closely with the relevant LAWA technical committees and draw directly on their findings.[22]

4.3.1.2 Data

The main data/information required for implementing and especially reporting is collected by local authorities, which have to report to the *Länder*. The collected data will be centralised in a web-based platform.[23] Based on this and co-ordinated regional and local plans, one River Basin Management Plan will be composed. Much of the necessary data are already available, but they have to be centrally collected and checked with regard to their comparability. In some cases they do not have the same format; sometimes the restructuring - according to hydrological boundaries - is therefore difficult to achieve.

As shown in the more detailed *U5 Core User Needs* report of the German Federal Agency (UBA) subchapter "Specific Information Needs of the User," the actual nomenclature (44 classes / 3 levels) is insufficient with regard to the Water Framework Directive:

- A refined Corine Land Cover classification (CLC) survey is needed regarding the classification key;
- For the realisation of the Water Framework Directive, a spatial resolution of 5 ha is necessary, especially regarding special cultures and settlement classes; and,
- Increasing the distribution of mulch seeding is important for the modelling of nutrient emission into river systems by diffuse agricultural sources. land use / land cover needs, related to reporting obligations on WFD and based on CLC nomenclature, are shown in the table 4.1: of the U5 Core User Needs report of the UBA.

In summary, the UBA needs land use / land cover data which is compatible to CLC and its classification scheme, but is however extended by a more detailed, additional fourth level (minimum mapping unit 5 instead of 25 hectares).

4.3.2 Sweden

4.3.2.1 Implementation Status and Identification of River Basin Districts and Authorities

The transposition of the WFD into national law is dependent on decisions in the Swedish Parliament, which should be reached by autumn 2003. The legal base for the implementation will be the Swedish Environmental Code, the adoption of an ordinance on the management of the water quality and of detailed regulations. The final designation of river basin districts

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[21] Länderarbeitsgemeinschaft Wasser (LAWA) 2003: *Arbeitshilfe zur Umsetzung der EG-Wasserrahmenrichtlinie* (LAWA Guidance Document to the Implementation of the WFD).

[22] Länderarbeitsgemeinschaft Wasser (LAWA) 2003: *Arbeitshilfe zur Umsetzung der EG-Wasserrahmenrichtlinie* (LAWA Guidance Document to the Implementation of the WFD).

[23] See: www.wasserblick.net.

and of the competent authorities has not yet been completed and will most likely also be finalised in autumn 2003. A Swedish Guidance Document (analogous to the German *Handlungsanleitung*) for the implementation of the WFD, which transposes the CIS Documents to the Swedish conditions, is still being prepared and is expected to be finalised in June 2004.[24]

The future river basin districts and their competent authorities have not yet been designated in Sweden. The responsibilities, working practices and decision-making cycles at a river basin level in the future therefore cannot be identified.

4.3.2.2 Data

The Swedish EPA has the co-ordinating responsibility for national environmental monitoring. Operational activities are delegated to other national and regional authorities, research institutes like the Swedish Environmental Institute (IVL), Swedish Meteorological and Hydrological Institute (SMHI), and the Swedish University of Agricultural Sciences (SLU).

The main problem is that not all impacts listed in the WFD are currently monitored and recorded, which may result in difficulties in meeting requirements for the first reporting cycle. Moreover, the accuracy of data collection varies between the different Swedish regions, with less detailed data (i.e. less resolution) available in the northern regions. Furthermore, a lack of quality checks has been noted in a number of cases and some data sets are not yet available in digital form.

According to the *U5 Core User Needs* report of the National Land Survey-Metria (MET),[25] the short term user needs for the case study on the Dalälven drainage basin are:

- Wall-to-wall datasets of forest indicators on productivity, biomass and clear cuttings covering the river Dalälven drainage basin; and,
- Improved source apportionment for nitrogen, to use a model for runoff simulation.

From a broad national sense and a regional perspective, taking into account the county administrations of today and the future, and considering the competent authorities in the river basin districts responsible for the WFD implementation, the long-term user needs are:

- Wall-to-wall data sets on diffuse pressures on surface waters from all types of land use, and indicators providing information on land use intensity and land use change. These data sets need to be updated regularly (different cycles depending on land use intensity) in a quality assured way, so that the changes indicated actually have occurred;
- A GIS based dataset of water bodies defined according to WFD principles, i.e. surface water bodies and catchments; and,
- Catchment based source apportionment for relevant aquatic indicators (e.g. nitrogen, phosphorus, carbon, base cations) capable of handling scenarios, as a basis for environmental monitoring, the formulation of programs of measures and of river basin management planning.

More specific user requirements can be found in the *U5 Core User Needs* dossier of MET subchapter “Specific Information Needs of the User”.[26]

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[24] Personal communication: Ms. Kerstin Nordström, National Land Survey - Metria (MET), Sweden.
[25] Output of the SAGE Project: *U5 Core User Needs,* National Land Survey - Metria (MET), Sweden.
[26] Output of the SAGE Project: *U5 Core User Needs,* National Land Survey - Metria (MET), Sweden.

4.3.3 Spain

4.3.3.1 Implementation Status and Identification of River Basin Districts and Authorities

In Spain, the "Permanent Commission of the National Water Council" met on the 10th of April 2003 in order to organise the work program for the transposition of the WFD. Parallel to this, the Environment Ministry put up internal juridical studies in order to reach the proposed transposition goals.

The transposition of the WFD into national law requires the adaptation of a number of laws (Water Act, Coast Act, etc.) and regulations in Spain. Due to the different levels of the regulations in which the WFD will be transposed, implying different legal processes, it is not possible to fix a date *a priori* when the implementation will be completed. But it is expected that the deadline of December 2003 will be met.

As in Sweden, no final decision on the number of River Basin Districts (RBDs) and their delimitation has been taken so far. However, Spain's long tradition of water management at the river basin scale (as required by the WFD) can be expected to facilitate the designation procedure. Currently there are 9 interregional basins and 5 other regional basins (including the 2 archipelagos). This scheme will probably continue to be operated in the future. A specific authority for each river basin establishes co-ordination mechanisms with other administrative units.

4.3.3.2 Data

The information that is currently accessible is sufficient for defining surface waters categories and for developing a typology of surface and groundwater bodies. However, some River Basin Districts lack sufficient biological data. This could become an obstacle in the definition of reference conditions and in the selection of provisional sites for the intercalibration exercise.

4.3.4 France

4.3.4.1 Implementation Status and Identification of River Basin Districts and Authorities

A draft law was passed by the French National Assembly in January 2002 that brings the two most important water acts in accordance with the provisions of the WFD. Furthermore, a new law is currently being drafted for the transpositions of the WFD into national legislation. The delineation of RBDs was completed in mid-2002 while the assignment of coastal and groundwater bodies is expected to occur in mid-2003.

For each RBD, a specific authority will be assigned as the responsible body. The competent authority in charge of the implementation will be the representative of the State in each district, the Basin Co-ordinating Prefect.[27] It is planned that a co-ordination mechanism will be established, especially in relation to coastal waters and existing administrative units in the district.

[27] The Prefect of the region in which the basin committee has its headquarters.

The French Ministry of Ecology and Sustainable Development published a formal instruction for the elaboration of the characteristics of the RBDs in February 2002. This national "Guiding Document" transposes the CIS documents. It outlines the methodological framework and sets up a timetable for the analysis of the characteristics, the review of pressures and impacts, the economic analysis and the registration of protected areas.

4.3.4.2 Data

Data collection has already started in the districts on the basis of the already existing databases. An evaluation of present gaps in data collection and of the need for new data is scheduled for the end of the first review period by 2004. Adjustments to the data collection process are to be implemented in the interim period of 2004 - 2008 for the updating of the district review which is necessary for the elaboration of the management plan in 2009.

4.3.5 Austria

4.3.5.1 Implementation Status and Identification of River Basin Districts and Authorities

Austria's territory lies entirely within the three international River Basin Districts - the Rhine, the Elbe and the Danube - which are shared with more than 25 riparian countries.

The Federal Ministry for Agriculture and Forestry, Environment and Water Management (BMLFUW) is in charge of the implementation process. Five working groups have been instituted to clarify details for implementation. They will produce national Guidance Documents. The greater public (e.g. Members of parliament, NGOs, Universities, associations) is involved via workshops, well in advance of the legal implementation.

Austria is going to incorporate the provisions of WFD into its national Water Act (*Wasserrechtsgesetz* 1959[28]). As a result of the consultation process unexpected and unprecedented broad number of comments were made because of a broad involvement of the interested public. The draft amendment has been sent to the Council of Ministers and should be passed by the Parliament by autumn 2003.

In most cases a formal rewording of existing national provisions was done in order to comply fully with all requirements of WFD. Articles of the WFD will be incorporated mainly into the National Water Act. Technical parts of annexes to the WFD will be integrated into existing legal acts or ordinances. The legal implementation will be finalised by the end of 2003 at the latest.

The Austrian Ministry for Agriculture and Forestry, Environment and Water Management will produce a first draft of the report to the Commission, based on existing data. In the second step, the Federal States *(Bundesländer)* will have the opportunity to comment on the produced maps and documents until September 2004. The Ministry will finalise the first characterisation by December 2004.

Austria will maintain existing national administrative structures (*Bund, Bundesländer*) which will be co-ordinated on a regional level. Transboundary water commissions, as well as the administrative structures of the Conventions for the protection of the Danube, the Rhine and

[28] Österreichisches Wasserrechtsgesetz (WRG) 1959. BGBl.Nr. 215/1959.

the Elbe, are used for co-ordination and for achieving a common understanding of the implementation of the WFD.

4.3.5.2 Data

In Austria,[29] the main data is collected centrally by the Austrian Ministry for Agriculture and Forestry, Environment and Water Management. Within the consultation phase of the *Bundesländer,* local and regional data can be included. The responsibility for the accuracy of data lies with the institution collecting the data. The BMLFUW is authorised to use the collected data, but does not own it.

The existing data set on point pollution sources is sufficient to produce the first characterisation of the RBDs. In the case of diffuse pollution, CORINE Land Cover (1990) will be used, which is currently updated from an accuracy of 25 ha to 10 ha. The use of EO systems is currently not foreseen as the existing data are satisfactory. A broader use will depend on the further development of the CIS-process and other EU regulations on water. In the future, the use of EO-services might be possible for:

- Identification of fallow land during winter time (EU Nitrate Directive 91/676/EEC);[30] and,
- Verification of edge strips along surface water bodies (EU Nitrate Directive 91/676/EEC).

4.3.6 United Kingdom

4.3.6.1 Implementation Status and Identification of River Basin Districts and Authorities

The implementation of the WFD in the UK is under the shared responsibility of the Scottish Executive (Scotland) and the Department of the Environment for Northern Ireland (Northern Ireland) as well as the Defra (Department for Environment, Food and Rural Affairs) and the Welsh Assembly Government (WAG) (England and Wales).

In Scotland a first consultation document was published in June 2001 which set out the Scottish Executive's initial proposals to meet the requirements of the Directive. A second, establishing firmer legislative proposals, was issued in February 2002. In March 2003, Parliament approved the Water Environment and Water Services (Scotland) for the transposition of the WFD into national legislation. Some secondary legislation will also be required and is expected to be completed by December 2003.

In Northern Ireland a major WFD scoping study has been completed identifying responsibilities of stakeholders (primarily Northern Ireland Government Departments, their Agencies and associated statutory bodies) in June 2003. In addition, a legal analysis has been carried out in May 2003. This analysis involved an examination of the legislative requirements of the Directive alongside existing legislation and the identification of any deficiencies to be addressed through new WFD transposing legislation. A Joint North/South Consultation Paper on International River Basin Districts (IRBD) was also launched. Responses to this consulta-

[29] Based on communication with Mr. Marent of the Austrian Ministry for Agriculture and Forestry, Environment and Water Management.

[30] The European Parliament and the Council 1991a: *Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources* (91/676/EEC).

tion exercise are still under consideration in conjunction with colleagues in the South. A third consultation paper, containing proposals for legislation, is under preparation.

The Government, together with the Welsh Assembly Government, will publish three consultation documents to transpose the WFD into domestic legislation in England and Wales. The first one was published in March 2001; the second - in October 2002. Their purpose was to identify the regulatory gaps that will need to be filled to ensure transposition of the WFD by December 2003. A third consultation paper, which is planned for 2003, will contain the draft regulations and an updated Regulatory Impact Assessment.

The delineation of RBDs in the UK has not been finalised yet, but the establishment of eleven river basin districts has been proposed. Defra and the Scottish Executives are considering options for the legal process for designating the two England/Scotland cross-border districts. For Scotland, it has been decided that one main River Basin District will be appropriate. This will require secondary legislation under the Water Environment and Water Services Bill (Scotland). For Northern Ireland, one internal RBD has been identified, as well as three international river basin districts shared with the Republic of Ireland. The government of the UK proposes the Environment Agency as the sole competent authority in England and Wales; for Scotland, the Scottish Environment Protection Agency will be the lead RBD authority. However, other responsible authorities are also likely to be appointed under the Water Environment and Water Services Bill (Scotland). In Northern Ireland, the DOENI (Department of the Environment of Northern Ireland) will be the principal competent authority.

4.3.6.2 Data

It is expected that the competent authorities have enough data to perform the first iteration of the required analyses and to prepare a first estimate of "good status" (according to the WFD) based on restricted biological, chemical and water quantity data, with the help of the presently available data.

4.3.7 Greece

4.3.7.1 Implementation Status and Identification of River Basin Districts and Authorities

In Greece, the transposition of the WFD into national legislation has not yet been completed. A committee of experts has been formed to study the technical, regulatory, social, economic and administrative implications of the Directive. The committee drafted a law that was examined by all the involved authorities in Greece. Including the comments, a final version has already been prepared. This new law for water and some additional pieces of legislation will allow the transposition of the WFD into national legislation.

Greece is currently proposing 13 RBDs but no final decision has been taken so far. The final decision concerning the delimitation (assignment of coastal and groundwater) is not taken now. According to the new legislation, Regional Water Directories will be established within each Water Region which have the responsibility of organising and co-ordinating water policy activities. They will be in charge of implementing the WFD. Supervision will be given by a National Water Service, the governmental authority with the overall responsibility.

4.3.7.2 Data

One of the main technical problems that Greece faces is that there are so few available data about the biological ecological quality elements in surface waters and, as a consequence of this, national classification schemes have not been developed until now. Methodologies and techniques concerning the identification of the parameters indicative of all biological, physico-chemical and geomorphological elements within each River Basin District, the establishment of reference conditions and the determination of appropriate monitoring frequencies and site numbers for each quality element still need to be defined.

4.3.8 Netherlands

4.3.8.1 Implementation Status and Identification of River Basin Districts and Authorities

The transposition of the WFD into national law has so far not been completed and is expected to be finalised during the course of 2003. While four national River Basin Districts have been informally agreed upon, the official designation procedure of the borders of the individual river basins within the Netherlands has not yet been completed. A formal document outlining the designation results is expected to be published in the course of 2003.

The authority in charge of the implementation of the Directive is the Ministry of Public Works and Transport, whose tasks include the competence for water. A national committee cooperates with other bodies of the public administration involved in water management, including levels of regional and local administration and public corporations in charge. Formal representatives of the Ministry are designated in each individual River Basin District which have the task of further organising the implementation process in the River Basin Districts by setting up or adapting administrative bodies. It is expected that these administrative bodies will start to work on the 2004 reporting obligations of the WFD in early 2003.

4.3.8.2 Data

The major problems is the establishment of an intercalibration network and gathering the biological information needed therefore.

The Netherlands will provide a GIS for the short term reporting obligations at a 1:1000.000 mapping scale.

4.4 INFORMATION REQUIREMENTS

4.4.1 Monitoring

Paragraph 32 of the Preamble to the Water Framework Directive identifies the need to monitor the water status on a systematic and comparable basis throughout the Community. In order to unambiguously evaluate the water quality, a corollary to this requirement is the need for comparability between results obtained not only by different laboratories but also at different times or places. Paragraph 44 of the Preamble calls for a committee procedure to ensure such comparability.

To achieve the environmental objectives, the WFD requires that Member States implement *programmes of measures* to monitor[31] the relevant biological components of the aquatic ecosystem before the end of 2006 (within six years after the date of the Directive's entry into force) (Article 8). The assessment of hydromorphological and physico-chemical parameters is required as well as the assessment of the ecological status based on the quality of the biological elements. The monitoring data aim to provide information on the initial assessment of the water status, assess the long-term changes both from natural and human activities, focus on short-term changes where waters are found to be at risk, and lead to measures to rectify the situation where problems may hamper the compliance with the environmental objectives of the WFD. As such, the WFD does not give strict requirements for each monitoring aspect. It mainly provides a framework outlining Quality Elements (QE) that must be defined by the Member States. Quality Elements provide the opportunity to tune in to specific local situations within each River Basin District.

For surface waters, this general framework defines the following QE:

Table 3: Quality-elements for different categories of surface waters[32]

Quality-element	Rivers	Lakes	Transitional waters	Coastal waters
Phytoplankton	X	X	X	X
Phytobenthos	X	X		
Macrophytes	X	X		
Macro-algae			X	X
Angiosperms			X	X
Benthic invertabrate fauna	X	X	X	X
Fish fauna	X	X	X	
Hydro morphological elements	X	X	X	X
Physico-chemical elements	X	X	X	X

The CIS Guidance Document on Monitoring for the Water Framework Directive provides guidance on the appropriate selection of quality elements and parameters.[33] The selection of quality elements has been based primarily on Annex V.1.1 and Annex V.1.2 of the WFD. It has to be seen as a selection of recommended quality elements and parameters and is intended as a guide only. Member States should use their own judgement based on local knowledge and expertise as to what specific sub-element or parameter will provide the best representation of catchment pressures for each quality element.

Annex 1 of this report includes a table that lists the main recommended quality elements and parameters, and the feasibility of EO for monitoring. Analysis of this table finds the following facts:

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31 In the context of the Directive, *monitoring* means the gathering of data and information on the status of water, and does not include the direct measurement of emissions and discharges to water. The latter is being dealt with by WG 2.1, IMPRESS.

32 Timmerman, J.G., Breukel, R.M.A. and P.J.M. Latour n.y.: *Implementation of Monitoring Requirements for the New European Water Policy*. Institute for Inland Water Management and Waste Water Treatment.

33 Common Implementation Strategy Working Group 2 July 2003: *EU Guidance Document: Guidance on Monitoring for the Water Framework Directive*. January 2003, available at http://forum.europa.eu.int/Public/irc/env/wfd/library.

- In most cases there is no consistent monitoring methodology for the quality elements and parameters across the EU;
- Most of the monitoring methods used do not meet the WFD requirements; and,
- Most of the existing classification requirements do not meet the WFD requirements.

EO-services will not be able to improve monitoring of all quality elements and parameters required by the WFD. But for some quality elements and parameters, EO can produce greater accuracy over large areas or can reduce overall costs for data sampling and monitoring. EO could also provide a common standard to which all Member States would adhere at the same costs, ensuring the comparability of results and the coherence of monitoring and evaluation methods employed.

For groundwater, the programmes shall cover monitoring of the chemical and quantitative status. A core set of parameters should be monitored. These parameters are: oxygen content, pH value, conductivity, concentration of nitrate and ammonium. Other monitored parameters must be selected on the basis of: (a) the purpose of the monitoring programme, (b) the identified pressures and (c) the risk assessments made using a suitable conceptual model of the groundwater system and the fate and behaviour of pollutants in it.[34]

4.4.2 Reporting

The Water Framework Directive contains a wide range of reporting and record keeping requirements. The Commission (Article 15) and the Public (Article 14) are the two named audiences for reporting obligations. Reporting to the Commission is formally a responsibility of the national governments of each Member State, but may be delegated to a “competent authority”. This authority, for example, can be International River Basin Commissions.

Among a number of reporting requirements, in relation to EO services, only two reporting issues are relevant:

Firstly, Member States shall submit summary reports of the analyses required under Article 5 (analysis of the water body's characteristics, a review of the impact of human activity, the status of surface waters and of groundwater), and the monitoring programmes designed under Article 8.

The WFD specifies which information represented in mapping format should be reported and when. But it gives very little information with regard to more detailed technical specifications. As a consequence, the format in which maps and data will be presented is unlikely to be harmonised among Member States. So far, no common consensus has been reached on the contents of the various maps, the scale and positional accuracy of the data, or on the reference system and projections used.[35] The use of EO could facilitate the issuance of comparable maps that adhere to a common standard, easing their subsequent interpretation and use across Member States.

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[34] Common Implementation Strategy Working Group 2 July 2003: *EU Guidance Document: Guidance on Monitoring for the Water Framework Directive*. January 2003, available at http://forum.europa.eu.int/Public/irc/env/wfd/library.

[35] Common Implementation Strategy Working Group 3 January 2002: *EU Guidance Document: Implementing the GIS Elements of the Water Framework Directive*. December 2002, available at http://forum.europa.eu.int/Public/irc/env/wfd/library.

Secondly, Member States are required to inform the Commission about the competent authorities that are designated to carry out the terms laid out in the Directive. These competent authorities might become the main users of EO services because most of them are in charge of data collection and monitoring programmes.

Table 4: Reporting obligations of the WFD

Subject	Article	Responsibility	To	Report due date	Frequency/ Review
List of competent authorities	3.8/Annex I	MS	COM	22/06/04	3 months after change
Characterisation of RBD human activity/ economic analysis	5, 15.2,	MS	COM	22/03/05	22/12/13, every 6 years thereafter
Monitoring programmes	8, 15.2	MS	COM	22/03/07	
RBMP	15.1	MS	COM	22/03/10	22/12/15, every 6 years thereafter
Progress on implementation of programme of measures	11, 15.3	MS	COM	Within 3 years of publication of RBMP	
Implementation status of the Directive	18.1, 18.2	COM	EP C	22/12/12	Every 6 years
Progress of MS in implementation	18.3	COM	EP C	22/12/06 22/12/08	
Interim reports on implementation of programme of measures	18.4	COM	EP C	22/12/15	Every 6 years

Notes: C - Council, COM - Commission, EP - European Parliament, MS - Member States

Countries often have to report what appears to be similar information to a number of different organisations. Some commitments for reporting are legally binding while others are morally binding.

It is now recognised by Member States, the European Commission, the European Environmental Agency (EEA) and other bodies with a stake in reporting procedures, that there is a need for “streamlining” the reporting process, gathering more useful and relevant information and making the exchange process as efficient as possible using modern technology.[36] Therefore the Commission developed the following common vision:

[36] Presentation by D’Eugenio at the LAWA Workshop: *Bericht 2004 als Eröffnungsbilanz zur Umsetzung der WRRL*, 22/23 March 2003 Bonn.

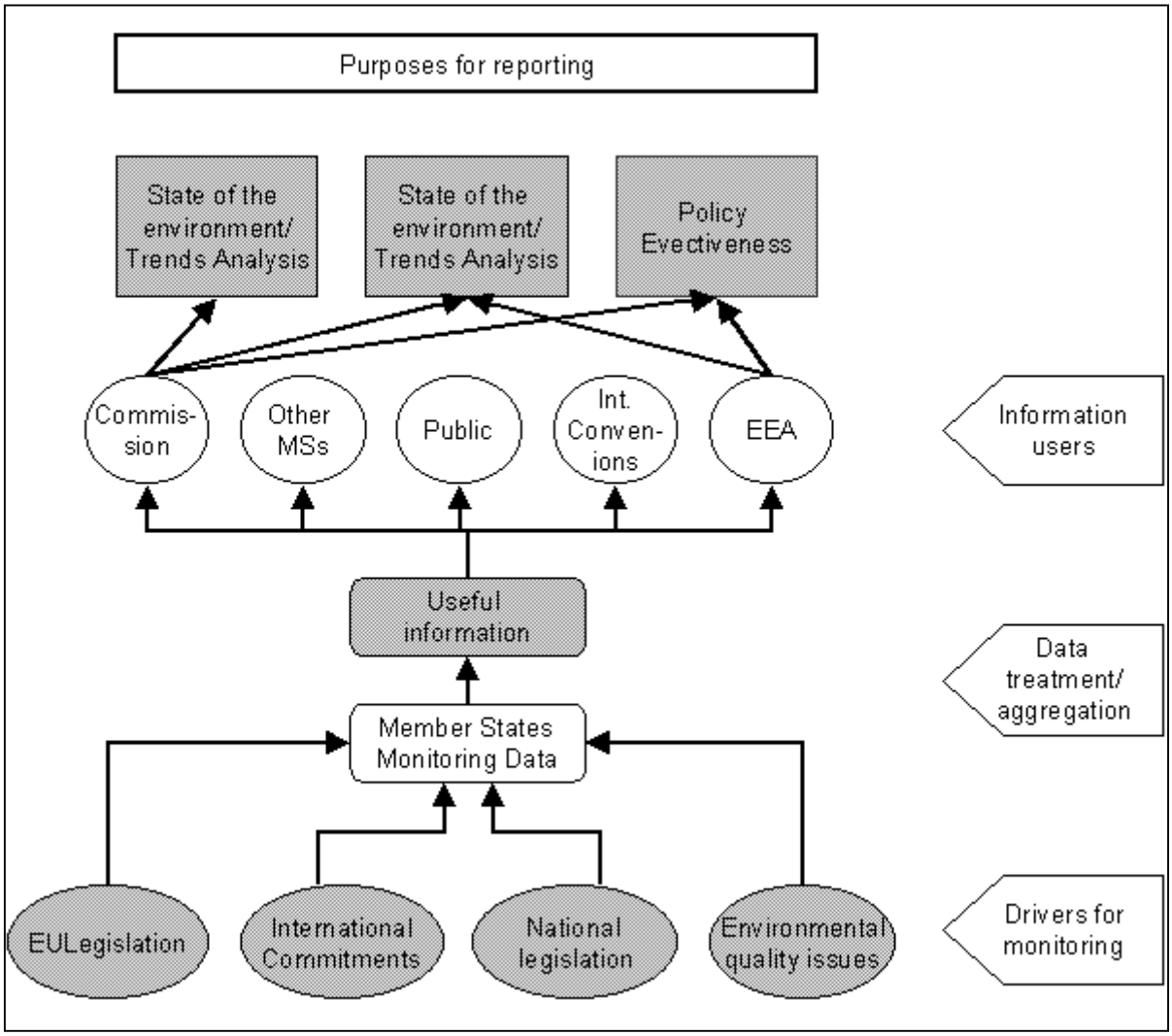

Figure 1: Vision of a future scheme for water reporting to the EU COM[37]

Starting from the Member State's monitoring system, this network should be designed on the basis of policy objectives which can serve different purposes and the objectives of several Directives.

The next and intermediate level is related to information generated through monitoring which need to be transformed into information that is useful for the various users (i.e. the Commission, the EEA, Member States themselves, the public and international organisations). The useful information needs of the various users would be designed on the basis of common assessment purposes and users.

The third level concerns the objectives of the monitoring/reporting:

[37] Adapted from D' Eugenio (2002).

- To assess state and trends in the environment in order to monitor progress;
- To check compliance with EU legislation; and,
- To evaluate policy effects and effectiveness (including costs).

The European Commission and the EEA are committed to starting the immediate development of a new, comprehensive and shared European data and information management system for water, including river basins. The system should be based on the concepts laid down in Figure 1 and should be fully implemented by 2010.[38]

4.5 LINKAGE BETWEEN EARTH OBSERVATION & THE WATER FRAMEWORK DIRECTIVE

The implementation of the WFD, managed through river basin management plans, will closely rely on monitoring programmes that should be operational by the end of 2006. The effectiveness of these programmes, and the success of the WFD implementation, will primarily depend on the ability to measure biological and chemical changes of the quality of water within the EU Member States and Accession Countries. In particular, fast and reliable techniques should be made available for the detection of accidental and permanent pollution that would call for possible remediation measures. Such techniques should be widely available in the countries concerned and at an affordable price. To date, however, there is no clear demonstration of equivalent existing methods, which hampers sound data comparisons.

The WFD does not foresee any special monitoring methods. The monitoring system will simply "ensure the establishment of programmes for the monitoring of water status in order to establish a coherent and comprehensive overview of water status within each River Basin District".[39]

Currently within the CIS document on Monitoring, Earth Observation tools are mentioned for two parameters in the list of quality elements only, namely:

- Biological quality element for coastal waters, parameter: Macroalgae/Angiosperms (Phytobenthos); and,
- Hydromorphological quality element in coastal waters, parameter: Structure of the intertidal zone.

But as was said in the foreword of the Guidance Document, it is a *living document* that needs continuous input and improvements as application and experience build up in all countries of the European Union and beyond. Thus it is not unlikely that EO will be much more recommended in future versions of the document.

Furthermore, as the CIS process is still dynamic, it may offer considerable chances for EO services, for example in relation to the WFD requirements on cost-effectiveness and comparability.

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[38] Presentation by D'Eugenio at the LAWA Workshop: *Bericht 2004 als Eröffnungsbilanz zur Umsetzung der WRRL*, 22/23 March 2003 Bonn.

[39] Article 8 Water Framework Directive.

4.6 POSSIBLE USERS OF EO DATA ON WATER: RELEVANT ACTORS/AUTHORITIES

Figure 1 shows possible users of water information in the terms of the WFD. But EO services on water could provide information to more than those mentioned above. Possible users may also include:

- The general public: In the WFD, public participation is regulated by Preambles 14 and 46, article 14 and Annex VII A (points 9 and 11). The need and the importance of sound information policy and active involvement of the public is recognised as a crucial condition to ensure the success of the Directive. It also highlights that information regarding planned measures and progress with their implementation needs to be provided at an early stage, well before final decisions are taken, in order to ensure the participation of the public in the setting up of river basin management plans;
- Authorities undertaking the monitoring programmes and reporting of the results to the European Union as required by the Directive;
- Parties taking part in the policy making process, like the Commission itself, national governments or local authorities;
- Research institutes (e.g. modelling); and,
- Emergency Units (public and private) for Civil Protection, aiming at the prevention of natural and man made hazards related to major accidents, disasters or calamities, to mitigate losses and damage to the population and material resources, and to help the population during emergency situations. They will have interests in EO data for flooding or drought forecasting; the first steps to do so have already been set.[40]

4.7 SYNTHESIS: WATER & EARTH OBSERVATION

Reporting obligations have a long tradition in EU water legislation and over the last years reporting procedures have been developed to provide the Commission with information relating to the implementation of legislation to protect water resources. The systems used have been widely extended over the same period (e.g. better computer systems, the internet, GIS etc.) and information requested has consistently increased.

The Water Framework Directive introduces a new approach to data and information collection and reporting, providing a more streamlined reporting process and a clearer distinction between the information needs of different actors at different levels.

Besides this the WFD also shifts monitoring requirements from the “classical” one point consideration to an area-oriented consideration. The focus has moved from water bodies to river basins. The identification and assessment of the significant pressures on the aquatic environment will request new monitoring networks. So the WFD presents an ideal opportunity for the development of an integrated data management system for water as well as requiring new monitoring techniques to generate the requested data.

Remotely sensed data have the inherent properties of being able to provide synoptic observations with high density over relatively large areas. However, what is normally measured by in-situ devices used in hydrology and what is observed by remote sensing devices may not

[40] See: http://www.esa.int/export/esaSA/ESAZODZPD4D_earth_0.html.

be exactly the same. By determining the correlation between in-situ measurements and EO data - assuming that EO data measurements may be less accurate at a given point but produce a much greater number of observations - one can produce greater accuracy over large areas or can reduce overall costs for data sampling and monitoring. Thus hydrologists and water resource managers should generally be aware of the fact that EO has to be considered as an ancillary tool with which it is possible to increase their data bases in a timely and cost-effective manner.

In general, four categories for using EO can be defined:

- Simple qualitative observations (e.g. differences in colour);
- Assessment of form (area, shape, length), pattern, geographic location, distribution, land cover, fractures, faults, lineations, etc.;
- Direct estimation of hydrologic parameters by correlating in-situ measurements with remote sensing observations, e.g.: soil moisture, snow depth or water equivalent, sediment load; and,
- Indicators on water quality: e.g. algae bloom, agriculture intensity in near-range, etc.

The development of a common Data and Information Management System (DIMS) will not be easy with many issues to be resolved, but it can still be a chance for implementing EO services.

Beside fulfilling reporting obligations, EO services could also support other issues like flooding. As case study 6 shows, satellites could provide up-to-date images from satellites supporting mitigation actions of the rescue teams.

5 POLICY AREA CONSIDERED: THE SOIL PROTECTION INITIATIVE (SPI)

5.1 POLITICAL CONTEXT AND POLICY IMPLEMENTATION STATUS

As a milestone towards European soil policy, the Council of Europe recognised in its *European Soil Charter*[41] (1972) the importance of soil as a resource. Since then European countries have undertaken various activities to protect their soil. The 1982 *World Charter for Nature*[42] called for the "productivity" of soils to be maintained or enhanced through measures which would safeguard the long-term fertility of soil, process of organic soil decomposition, and prevent erosion and all other forms of soil degradation.[43] The next step in soil policy was the 1992 UN Conference on Environment and Development which adopted the Agenda 21,[44] with Chapter 10 setting an integrated approach for the planning and management of land resources.[45] Following this conference, the Programme for the *Further Implementation of Agenda 21*[46] addresses the soil policy in the context of land and sustainable agriculture.[47]

Other relevant international binding agreements and initiatives on soil and soil protection include the Convention on the Protection of the World Cultural and Natural Heritage (1972), the World Soil Charter (1981), the World Charter for Nature (1982), the Convention on Biological Diversity (1992), the Convention to Combat Desertification (1994) and the Alpine Convention and its Protocol on Soil Protection (1998).

In addition to the *European Soil Charter* (1972), the Council of Europe adopted Recommendation No. R(92)8 in 1992; it is particularly relevant to soil protection policies at the European level and sets forth a number of fundamental principles for the Soil Protection Policy.[48] One of the first initiatives considering soil protection as a separate policy area at the EU level was the 1998 workshop on Soil Protection Policies within the European Union organised in Bonn, Germany.[49] Recognising a need for future actions on soil protection in the European Union, the workshop established a platform for further soil protection activities. The participants agreed on the Bonn Memorandum that asked for integration of soil protection policy in general EC Environmental Policy[50] and established the European Soil Forum (ESF).[51] This co-

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41 European Environment Agency (EEA) 1995: *Europe's Environment - The Dobris Assessment*. Copenhagen, Denmark.

42 United Nations (UN) 1982: *General Assembly Resolution 37/7: World Charter for Nature.*

43 United Nations (UN) 1982: *General Assembly Resolution 37/7: World Charter for Nature.* See principle 10 and 11.

44 United Nations (UN) 1992: *Report of the United Nations Conference on Environment and Development*. Rio de Janeiro, 3-14 June 1992.

45 Agenda 21 does not contain a specific chapter on soil, but sets implications relevant to soil policy.

46 United Nations (UN) 1997: *General Assembly Resolution 19/2.*

47 United Nations (UN) 1997: *General Assembly Resolution 19/2.* See Paragraph 62.

48 The Council of Europe 1992: *Recommendation No. R(92)8 of the Committee of Ministers to Member Sates on Soil Protection*. Adopted by the Committee of Ministers on 18 May 1992 at the 476th meeting of the Ministers' Deputies.

49 International workshop „Soil Protection Policies within the European Union" held in Bonn, Germany 9 to 11 December 1998. The participants of the workshop were experts from the European Commission, the European Environmental Agency, the Member States, the Accession Countries and other countries, like Norway and Switzerland.

50 Measures for the protection of soil resources that are part of environmental policy in a general sense have been and can be adopted on the basis of Article 130s (1) of the EC Treaty.

51 For more information see: http://www.ecologic.de/project_pages/125.html.

operation continued with the first meeting of the European Soil Forum in November, 1999, in Berlin.[52] The first ESF envisaged the development of future actions and the integration of soil protection in other policy areas. Political, technical and scientific aspects of soil protection were discussed and the participants underlined their commitment to soil protection and the sustainable use of soil resources. The ESF identified the need to raise awareness of soil issues among policy makers and the public and to analyse the status of soil legislation in Europe.

In 2002, the 6th Environmental Action Programme (EAP)[53] was adopted which identifies soil as a non renewable resource under pressure and sets out the objective to protect soil as a natural system in general and specifically against erosion and pollution. In order to approach the issue systematically, the programme proposes a "Thematic Strategy for Soil Protection" to be produced by 2004, that will be supported by EU research programmes and create the basis for a community soil policy. At the beginning of 2002, the European Commission published a communication "Towards a Thematic Strategy for Soil Protection"[54] that outlines the scope of such a strategy and is the first document of the Commission that deals comprehensively with the issue of soil protection. It puts soil on the political agenda at the same level of protection as air and water and creates a new policy area.

The Environment Directorate-General (DG) of the European Commission has the main responsibility of developing the thematic strategy and of steering the process. In the process of the development of the soil strategy, the European Commission co-operates closely with the Member States, Candidate Countries, European Institutions, networks of regional and local authorities and a broad community of European-wide stakeholder organisations, such as civil society, NGOs, research institutes, industry and international and professional organisations. To support these activities an Advisory Forum and five Technical Working Groups (TWG) have been established for the priority areas, namely erosion, organic matter, contamination, monitoring and research. The co-ordination of the five Technical Working Groups falls under the responsibility of a Technical Co-ordination Group and Secretariat that is chaired by the

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52 European Soil Forum held in Berlin, Germany 24 to 26 November 1999. Participated 90 representatives from 22 countries. For more information see: http://www.ecologic.de/project_pages/127.html.

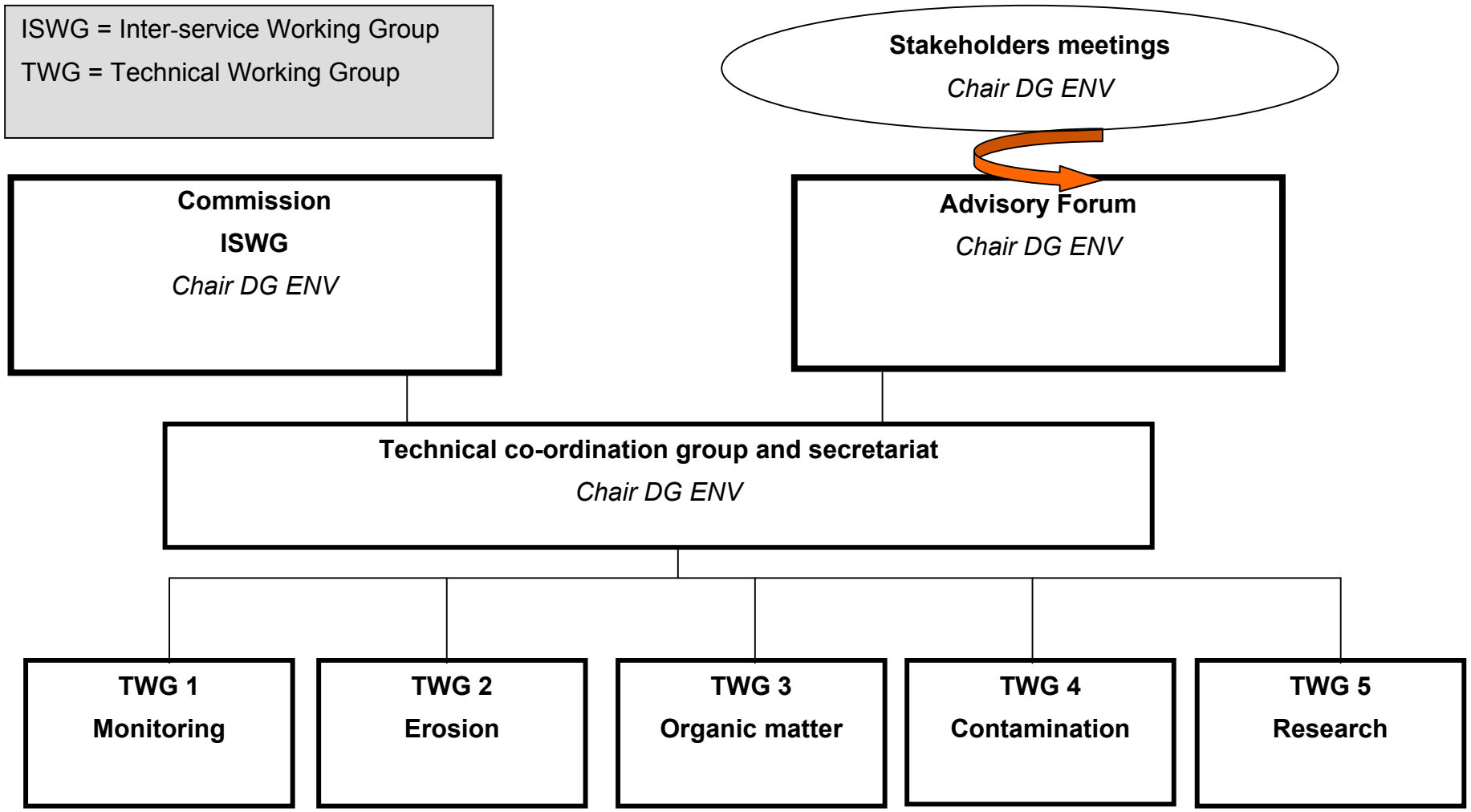
53 Decision No. 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environmental Action Programme was published in Official Journal L 242 of 10/9/2002. For more information see: http://www.europa.eu.int/comm/environment/newprg/index.htm.

54 European Parliament and Council 2002: *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.* Published in Official Journal L 242 of 10/9/2002.

Environment DG. In addition, the Commission Inter-Service Working Group with members from the European Commission, the Joint Research Centre (JRC), the EEA along with an Advisory Forum on EU Soil Policy - with representatives from Member States and the Candidate Countries - was created.[55] Diagram 1 gives a graphical presentation of the organisational set-up involved in the process of a Community policy development on soil.

[55] Commission of the European Communities 2002c: *DG Environment Working Document on the Proposal for Organisational Layout for the Work Plan on Soil Protection 2003-2004.* Brussels: European Commission.

Diagram 1: Soil Policy Development – Organisational Set-up



5.2 THE EUROPEAN SPATIAL DEVELOPMENT PERSPECTIVE (E.S.D.P)[56]

In the communication "Towards a Thematic Strategy for Soil Protection", a distinction is made between soil, which is the subject of this communication, and land use, which will be the subject of a separate communication addressing the territorial dimension.

The Amsterdam Treaty established that "environmental protection requirements must be integrated into the definition and implementation of Community Policies and activities in particular with a view to promote sustainable development". The soil sector, as well as the agriculture, transport and energy sectors are recognised as the key sectors for spatial planning and development. Moreover, a number of Community policies make use of territorial categories, for example in the case of the implementation of legal provisions in the field of environmental protection (e.g. soil sealing, soil erosion, areas selected for protecting given habitats and species of fauna and flora under the network Natura 2000, etc.).

Spatial planning integrates spatial dimension in sectoral policies through a territory based strategy. It is the result of decision makers trying to balance different interests (e.g. economic, social, etc.) with different stakeholders (e.g. public, industry, etc.) in order to prepare a plan defining the use of an area. Soil protection is very closely linked to the issue of spatial planning.[57] Essential soil functions are lost or deteriorated by land development (land use, land cover); and typically the best soils are thinned out by erosion or covered by suburbs.[58]

The 6th Environmental Action Programme clearly mentions the relationship between land use and environment. The choice of type and intensity of land use strongly influences the environmental conditions in an area. As a result, spatial planning is one key element to protect soils. Besides the Soil Protection Initiative, the European Spatial Development Perspective (ESDP) is one of the major policies that will have substantial impact on the issue of soil protection in the future. A number of policy options of the ESDP may contribute to the development of soil policy.

The purpose of this initiative is to add a spatial dimension to European regional policy and to define policy objectives and general principles of spatial development at the Union level, while respecting its diversity. The European Spatial Development Perspective is based on the EU aim of achieving a balanced and sustainable development policy, particularly by strengthening economic and social cohesion.

The ESDP is the result of intensive discussion among Member States and the European Commission on the expected spatial development of the EU. In 1993, the Belgian Presidency made the proposal to draw up the ESDP. After that the Spatial Development Committee,

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56 Committee on Spatial Development 1999: *ESDP - European Spatial Development Perspective. Towards Balanced and Sustainable Development of the Territory of the European Union*. Luxembourg: Office for Official Publication of the European Communities.

57 There is a different understanding of spatial planning across Europe. The traditional understanding of planning is quite different between the UK and Germany. In Germany spatial planning (*Raumplanung*) refers generally to deliberate influence on spatial development of different interests in an area. In the UK spatial planning is generally understood rather narrowly. The term "town and country planning" describes in essence the statutory planning process of development control and development plan preparation. For further information see: Moll, M. 2002: *Interreg IIC North Sea Programm - Successful Transnational Planning?:* University of Dortmund.

58 Forman, R.T.T. 1999: *Land Mosaics, The ecology of landscapes and regions*. Cambridge University Press.

comprising representatives of the Commission and national officials, drew up a number of drafts which resulted in the final adoption of the ESDP, in Potsdam, May 1999 by an informal Council of ministers responsible for spatial planning.[59]

The ESDP is an intergovernmental Guidance Document that is not legally binding. It outlines a framework for policy guidance to improve co-operation among Community sectoral policies having a significant impact in spatial terms. The document was drawn up because it was considered that the work of Member States complemented each other best if directed towards common objectives for spatial development. In accordance with the principle of subsidiary, it is applied at the most appropriate level, as desired by the various parties engaged in spatial development. The desired co-operation among those engaged in spatial planning at various levels will help avoid contradictions or conflicting measures.

In May 1999 in Potsdam, Germany, the Ministers responsible for the Spatial Planning of the EU - after the preparation of the ESDP - launched the "European Spatial Planning Observatory Network" (ESPON Programme). Specialised research institutes in the Member States should subsequently support political co-operation through joint studies on spatial development.

The programme is implemented in the framework of the Community Initiative INTERREG III. Under the lead of Luxembourg, the EU Member States have elaborated a joint application with the title "The ESPON 2006 Programme - Research on the Spatial Development of an Enlarging European Union". The European Commission adopted the programme on 3 June 2002. Using the ESPON 2006 Programme, and by addressing an enlarged EU territory and larger territorial entities, the Commission and the Member States expect to have at their disposal:

- A diagnosis of the principal territorial trends at the EU scale as well as the difficulties and potentialities within the European territory as a whole;
- A cartographic picture of the major territorial disparities and their respective intensity;
- A number of territorial indicators and typologies assisting in setting European priorities for a balanced and polycentric enlarged European territory; and,
- Integrated tools and appropriate instruments (databases, indicators, methodologies for territorial impact analysis and systematic spatial analyses) to improve the spatial co-ordination of sector policies.

As indicated in the European Regional/Spatial Planning Charter,[60] regional/spatial planning gives geographical expression to the economic, social, cultural and ecological policies of society. The fundamental objectives of European regional/spatial planning are:

- A balanced socio-economic development of the regions;
- An improvement of the quality of life;
- A responsible management of natural resources and protection of the environment; and,
- A rational use of land.

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[59] See also http://europa.eu.int/scadplus/leg/en/lvb/g24401.htm.

[60] The European Regional/Spatial Planning Charter was adopted at the 6th Conference, 20 May 1983 in Torremolinos, Spain (Torremolinos Charter).

At the European Conference of Ministers responsible for Regional Planning (CEMAT),[61] in September 2000, in Hanover, the Ministers adopted the Guiding Principles for Sustainable Spatial Development of the European Continent, giving a broad vision of the concept of sustainable spatial development. They were adopted in January 2002 within the framework of a recommendation[62] and were presented at the UN World Summit on sustainable development in Johannesburg in September 2002.

The “Guiding Principles” are not legally binding and represent the policy reference document for numerous spatial development measures and initiatives made on the European continent, in particular with regard to transnational and international co-operation. They aim at bringing the economic and social requirements to be met by the territory into harmony with its ecological and cultural functions and therefore contributing to long-term, large-scale and balanced spatial development. Although the European continent is marked by the diversity derived from its history and its geography, the "Guiding principles" need to be implemented evenly, both at the national and at the local and regional levels. Adopting the “Guiding Principles” and taking them into consideration in spatial development policy decisions will significantly facilitate Europe-wide co-operation aimed at creating a regionally-balanced and sustainable Europe.

As the discussion has shown, the development of a comprehensive EU Soil Policy is only at its beginning; the development of such a strategy will be an itinerary process which will take time. However, important initiatives that will steer the process and in the long run shape the Community’s soil policy will be launched in the next two years. In order to influence the agenda and the outcome of the process, it will be of vital importance for all interested stakeholders to follow, and where possible, get involved in the activities that are planned by the European Commission.

5.3 PROCESS OF IMPLEMENTATION

At this time, there is no single legally binding instrument on soil at the European Union level, but there are numerous legally binding instruments that relate to and have an impact on soil protection policy. At the EU level, soil cuts cross environmental and other policies. Apart from environmental policy, where a large number of soil relevant legislation - such as various directives and regulations - can be found (e.g. water, air, waste etc.), soil related legislation can also be found in the Common Agricultural, Regional, Transport, Research and Developmental Co-operation Policy. In addition, a number of proposals for environmental legislation (e.g. groundwater, environmental liability, air quality, biodegradable waste, sewage sludge, mining waste etc.) and other initiatives, for instance as on pesticides, sustainable use of resources, planning, and environment, that are currently being undertaken, are going to affect soil protection both directly and indirectly. The treatment of soil by legal and policy instruments has evolved from an anthropocentric approach to a cross-sectoral and holistic approach.[63]

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61 See also http://www.coe.int/T/E/Cultural_Co-operation/Environment/CEMAT/.

62 European Conference of Ministers responsible for Regional Planning (CEMAT). Recommendation Rec(2002)1 of the Committee of Ministers to Member States on the Guiding Principles for Sustainable Spatial Development of the European Continent, adopted on 30 January 2002.

63 Tarasofsky, R.G. and R.A. Kraemer 1998: *International Political Commitments and Legal Obligations Concerning Soil Conservation: A Preliminary Examination*: Ecologic, Germany.

The activities in the framework of the development of the Thematic Strategy for Soil Protection will be based on initiatives within other environmental policies, integration of soil issues into other policy areas, soil monitoring and new actions that will be based on monitoring results. Core statutory elements will be proposed for a piece of soil monitoring legislation and a communication on soil erosion, soil organic matter loss, and soil contamination. The soil monitoring legislation, to be proposed by 2004,[64] will be the initial basis for the Community's soil policy, and more legislation in this area might be expected. In addition, during 2003 the Commission plans to present a Communication on "Planning and Environment the territorial dimension",[65] addressing rational land use planning and taking into account the need for sustainable management of soil resources.

Various initiatives and institutions are set-up by the European Environment Agency, as well as various technical operational activities, such as: European Topic Centre on Terrestrial Environment (ETC-TE) which focuses primarily on land cover, spatial analysis, soil and contaminated sites; European Soil Bureau (ESB); and European Environmental Information and Observation Network (EIONET) (see chapter 7.5.1).

5.4 NATIONAL IMPLEMENTATION STATUS IN SELECTED EUROPEAN COUNTRIES

At the national level, soil legislation differs significantly among European Member States, nevertheless there is a common understanding in Europe for the need of soil protection policy. There have been a multitude of actions by the EU Member States and other European Countries, reflecting the specific challenges of each country.

At the individual country level, widely different types of administration exist; for example, in Germany the Federal government has law-making powers, and there is a second level of 16 Federal States *(Bundesländer)*, each with the power to make binding legislation on soil protection and the environment. Other countries have widely varying systems.

National soil monitoring programmes have already been implemented in some countries and are under consideration in others. In many cases, the monitoring systems were designed to suit different research programmes or for soil management purposes. The soil aspects included in the monitoring survey can be very different; for example, monitoring of dangerous substances, such as heavy metals, is important in some countries, while in others, erosion is monitored as a major soil problem.

Not much of the national legislation is related to the soil medium directly; in many cases, it relates directly to air or water (surface and ground water) and only indirectly to soil. Some of the legislation relates to other media or to health aspects and considers soil properties indirectly via ecological functions or human-activity-related functions of soil, e.g. biomass production, filtering water as a source of raw material.

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[64] Commission of the European Communities 2002c: *DG Environment Working Document on the Proposal for Organisational Layout for the Work Plan on Soil Protection 2003-2004.* Brussels: European Commission.

[65] There is not a text available of this communication yet. Environment DG is working on it. At the moment it is still not clear when exactly this envisaged communication related to land use and spatial planning might be published. Interview with Mr Chris Steenmans from EEA, 1 September 2003.

The majority of countries has implemented policies, legislation or agreements which relate directly or indirectly to soil at the European level, such as the Nitrate Directive, which sets a limit on the amount of organic and inorganic nitrogen fertilisers that can be applied to soil, and the Sewage Sludge Directive, which regulates the use of sewage sludge in agriculture thus prevents harmful effects on soil. The Habitats Directive, the Groundwater Directive, the Dangerous Substances Directive, and the Waste Directive include some soil aspects.

More detailed country information on soil monitoring and assessment framework of seven European countries is presented below.[66] Austria, France, Germany, Greece, the Netherlands, Spain and Sweden are considered in this policy review. These countries were selected on the basis of their participation in the SAGE team.

5.4.1 Austria

5.4.1.1 Implementation Status and Identification of Responsible Authorities

The Federal Constitutional Law on Comprehensive Environmental Protection declared “Soil protection” as a national target. However, no comprehensive federal law on soil protection exists in Austria. Nevertheless, Soil Protection Acts have been adopted in four provinces; drafts are under preparation in two other provinces.

More than 10 years ago, soil monitoring activities started in Austria. Few but intensively investigated soil monitoring sites have been established because of technical and financial reasons. The Institute of Soil Science at the University of Agricultural Science in Vienna, on behalf of the Federal Environmental Agency, and in co-operation with the Austrian Soil Science Society, has developed a recommendation for soil monitoring in order to achieve a uniform procedure in implementing soil monitoring sites.

5.4.1.2 Data

A soil information system (BORIS) developed by the Austrian Federal Environment Agency has existed for more than 10 years already. As of 2001, the database held more than 500,000 records from over 5,000 sites and a soil map of Austria at the scale of 1: 750,000. Two forms of the data are available via Internet: BORIS INFO - for the public - provides meta data; and BORIS EXPERT - for those institutions which have provided data for the information system and are accepted as licensed institutions for access - provides the complete database.

Three principal systems of soil survey exist in Austria. They are:

- The Federal Forest Research Centre (FFRC) which implements the forest soil survey comprising forest site mapping and soil monitoring. The survey consists of 514 plots arranged in a grid of 8.7 by 8.7 km;

[66] The country information is based on personal interviews as well as it draws on the report: European Environment Agency (EEA) 2001b: *European soil monitoring and assessment framework*. EIONET workshop proceedings. Technical Report 67, prepared by Sigbert Huber, Alexandra Freudenschuß and Ulrike Stärk. Copenhagen.

- The financial administration in co-operation with the Federal Office of Surveying which carries out the soil taxation survey of agricultural land. The maps are drawn to scales of either 1:2,000 or 1:2,800; and,
- Since 1958, the Federal Institute of Soil Survey and Soil Management, which carries out the systematic mapping of agricultural land in Austria for the soil-management survey. As of 2001, about 98 percent of the agricultural land has been surveyed and maps of 144 mapping regions, representing an area of 63 percent of agricultural land, have been produced.

Moreover, the provincial governments established an intensive environmental-soil survey programme. As of 2001, all provinces have finished the surveys and Tyrol has carried out a replicated environmental-soil survey. In order to create a basis for comparable soil data all over Austria, a recommendation for carrying out an environmental-soil survey was developed by a working group of the Austrian Society of Soil Science (ASSS).

5.4.2 France

5.4.2.1 Implementation Status and Identification of Responsible Authorities

At the national level, a number of public organisations are dealing with soil issues, e.g. soil monitoring, mapping and agricultural aspects, as well as with contaminated sites problems.

On the basis of a proposal of the Ministry of the Environment, the Ministry of Agriculture, the French Environmental Institute (IFEN) and National Institute of Agronomic Research (INRA), a national framework for soil mapping and monitoring at local, regional, and national levels is organised (called DINIOS “Dispositif National d’Inventaire et d’Observation des Sols”).

5.4.2.2 Data

Two major soil data requirements are defined by DINIOS:

- **Soil mapping.** Regarding soil mapping, two programmes are established. The “pedological map of France” programme (CPF) which produces maps at a 1:100,000 scale and employs detailed studies in order to prepare soil-distribution laws. Another programme, “Soil Inventory, Management and Preservation” (IGCS), aims to prepare a map at a scale of 1:250,000; and,
- **Soil monitoring.** It is planed to set-up a 16 km square-based network RMQS (Réseau de Mesure de la Qualité des Sols). It would represent 2,360 plots covering the entire French territory, on which 514 are already implemented for the forests monitoring network (as of 2001). It is also planned to define sampling and analysis methodologies in order to document each 16 km side cell on environmental aspects using the existing national geographic databases: hydrology, road traffic, industrial activities, etc.

Regarding contaminated soils, two main databases are dedicated to the management of contaminated sites and soils:

- **BASOL** (‘Base des Sites et Sols pollués’) is a national data register under the responsibility of the French Ministry of the Environment containing a comprehensive description of polluted sites and which is continuously updated. It concerns places where clean-up actions are necessary; and,

- **BASIAS** ('Base des Anciens Sites industriels et Activités de Service') is a database for old industrial sites. The French geological and mining survey (BRGM) is working for the Ministry of the Environment in order to make an inventory of industrial sites (abandoned or not) which are the focus of a specific legislation for the environmental protection.

There is also a number of other public bodies involved in soil issues in France.[67]

5.4.3 Germany

5.4.3.1 Implementation Status and Identification of Responsible Authorities

The German Federal Government has law-making powers and there is a second level of 16 Federal States *(Bundesländer)*, each with the power to make binding legislation on soil protection and the environment. The data exchange between the federal Government and the *Länder* is organised by special regulations.

5.4.3.2 Data

The monitoring programmes for soil in Germany are operated either at the Federal States or federal level. Most of these programmes are managed at the Federal States level, because the Federal States are the owners of the data. At the federal level, the German Federal Environment Agency (UBA) collects the data for soil protection through the programme on permanent monitoring sites (BDF) and background values for heavy metals. In addition, the Federal Institute for Geosciences and Natural Resources (BGR) collects and assesses geologic and pedogenetic soil data on the federal level.

As of 2001, the programme of "permanent soil monitoring sites" comprises 794 sites within 16 Federal States. The programme investigates agricultural sites, forest sites and municipal sites and focuses mainly on the chemical status of soils as well as input/output estimates. The forest soil analyses are partly supported by the EU.

The German Federal Environment Agency supports the idea of a harmonised European monitoring network and defines terms of special importance, e.g. the definition of background values for heavy metals, or the terms "built-up area," "potential erosion risk" and "actual erosion risk".

[67] Also involved are: Ministry of the Environment: http://www.environnement.gouv.fr; IFEN, the French Institute of the Environment: http://www.ifen.fr; INRA/SESCPF; National Institute for the Agronomic Research/Service for the study of soils and the pedological map of France: http://www.inra.fr/; BRGM, the French Geological and Mining Survey: http://infoterre.brgm.fr; ADEME: the National Agency for Environment and Energy: http://www.ademe.fr. The information has been collected from: D. King, D. Arrouays, INRA/SESCPF; D. Darmendrail, BRGM; E. Normant, Ministry of the Environment.

5.4.4 Greece

5.4.4.1 Implementation Status and Identification of Responsible Authorities

In Greece, the monitoring of forest soils is carried out with regard to Council Regulation (EEC) No. 3528/86 and the Geneva Convention (Long-Range Transboundary Air Pollution, Geneva 1979, International Cooperative Programme forests), both of which deal with the effects of atmospheric pollution on forest.

5.4.4.2 Data

The monitoring of forest soils is performed at two levels.

- **Level I.** In 1998, approximately 100 Level I plots were established, on a 16 x 16 km grid, in forest areas throughout the entire territory of Greece in order to survey "forest conditions" and look for relations between biotic and abiotic (e.g. including atmospheric pollution) parameters; and,
- **Level II.** In 1995, four permanent experimental Level II plots were established in representative forest ecosystems in Greece, where a large number of ecological parameters are intensively monitored, aiming to find relationships between the forests conditions and the monitored parameters. In connection with this, soil is also monitored.

5.4.5 Italy

5.4.5.1 Implementation Status and Identification of Responsible Authorities

Soil in Italy is a very problematic issue, due to the great variety of soil types and complex space distribution as well as the likelihood of potential threats, such as: erosion, acidification, salinisation, compaction, desertification, accumulation of toxic substances, and loss of biodiversity.

5.4.5.2 Data

As of 2001, soil quality data were not comprehensive. For example, 433 pedological maps in Italy were produced, of which only one third are in a digital form. Moreover, there are about 200,000 national observation points, whereas those that are described and analysed are about 20,000. Most useful information comes from regional or local data; however, they are often non-homogeneous, hardly comparable, and contain poorly related meta-information.

The new legislation on local contamination will allow the transferring of all information, through regional and local authorities, to the "national survey of potentially-contaminated sites" and eventually to the "national inventory of cleaned-up sites". For these activities, the National Agency for Environmental Protection (ANPA) defined database requirements and data-transfer protocols at the national level.

As for land use, the reference data at the national level are those derived from the Corine Land Cover programme and those developed through the National Statistical Institute (ISTAT), a relevant source for other environmental information as far as driving forces and pressures are concerned.

To solve the problem of data availability, the most important actions carried out by ANPA are linked to the reorganisation of the national environmental information system network (SINAnet), and to setting up a soil monitoring and assessment network. The SINAnet network closely resembles the EIONET structure with the regional focal points (PFRs), the national topic centres (CTNs) and the main reference institutions (IPRs) under the co-ordination of ANPA. CTNs bring together several regional environmental protection agencies (ARPAs) and IPRs to carry out activities according to long-term programmes. Each CTN supports ANPA in setting up common rules and homogeneous qualitative standards. Moreover, CTNs also co-operate in defining environmental quality standards, state-of-the-art methods on soil analysis and design criteria for a national soil monitoring and assessment network.

5.4.6 Netherlands

5.4.6.1 Implementation Status and Identification of Responsible Authorities

Soil quality is one of the major problems in the Netherlands. The main issues of concern focus on chemical pollution of the soil. Both the effects of local pollution and diffuse pollution on soil quality are monitored in the Netherlands.

5.4.6.2 Data

Both the local government and the public are responsible for the development of a comprehensive national local soil pollution monitoring system. The data are collected by the four big cities and the 12 provinces. Together with the National Institute for Public Health and Environment (RIVM), the local government and the public works on the development and implementation of new indicators for a more comprehensive soil clean-up monitoring. The data collected by provinces and cities is integrated and used by the RIVM on the basis of the yearly environmental report.

The soil quality monitoring on diffuse pollution is carried out in the national soil monitoring network, conducted by RIVM in co-operation with various other institutes. In addition to the national network, several provinces have started their own soil monitoring networks, in accordance with the methodology of the national network. The national soil monitoring network has been in place since 1993. Its main objective is to control the changes in soil quality over time. All together there are 200 sample locations.

5.4.7 Spain

5.4.7.1 Implementation Status and Identification of Responsible Authorities and Data

There is no special legislation on soil pollution in Spain. However, the Waste Act issued in 1998 supports the legal framework in the field of polluted soils. This Act separately identifies polluted soils as one of the issues and addresses different aspects of soil pollution: environmental assessment and recovery of registered contaminated soils, the discovery of those not initially considered, and the prevention of new situations.

5.4.7.2 Data

In 1999, the Spanish Ministry of Environment created a commission on the development for technical aspects of the Waste law. The commission prepared a list of priority pollutants of soils in order to focus the investigation of potentially-polluted sites, taking into account a limited number of substances, recognised as priorities by the international community or of specific interest in the national area. On the basis of the above mentioned pollutant list and calculated concentration levels in soil, different uses for soil (industrial, residential and agricultural) were defined. However, the levels of concentrations have no legal implications as they are formulated only for investigative tasks.

5.4.8 United Kingdom

5.4.8.1 Implementation Status and Identification of Responsible Authorities

Historically, soil monitoring in the UK has been undertaken for agricultural or environmental purposes. Monitoring policy is decided directly in Scotland and Northern Ireland, or by regional consultation between England and Wales. This has resulted in several soil monitoring schemes.

5.4.8.2 Data

The annual representative soil sampling scheme (England and Wales) survey began in 1969. It gives an estimate of the status of agricultural soils in relation to changes in agricultural practices. The total number of sites sampled under this scheme is approximately 900. The national soil inventory (England, Wales, and Scotland) began in the late 1970s. It gives an estimate of the distribution of soil types and their properties. The inventory is based on a 5 km grid. About 5,700 sites were sampled in England and Wales, and approximately 800 in Scotland. The soil-geochemical survey of Northern Ireland was carried out between 1988 and 1994 with approximately 6,000 sample sites. The countryside survey (England, Wales and Scotland) was carried out in 1978, 1984, 1990, and 1998 in 276, 1 km square plots representing the variety of existing landscapes. The environmental change network began in 1994. Soil measurements are made at seven sites in England, one site in Wales, three sites in Scotland and one site in Northern Ireland. Soil samples are taken by soil layer and by fixed depth at the start of the programme, then at 5 year and 20 year intervals.

Different chemical and physical parameters are measured in each of these monitoring schemes, such as nutrient status, organic matter, biodiversity and heavy metal contamination. All the data from these different soil monitoring schemes are stored in separate databases.

5.5 INFORMATION REQUIREMENTS

As Sections 8.1 and 8.2 have introduced, soil policy at EU level is still in the development phase, hence there is no directive or regulation that directly focuses on soil information, inter alia, monitoring, and reporting requirements. Nevertheless, the soil protection communication

"Towards a Thematic Strategy for Soil Protection"[68] foresees the preparation of the legislative proposal for soil monitoring in 2004.[69]

5.5.1 Monitoring

Concerning future soil protection, the "Thematic Strategy for Soil Protection"[70] indicates that "the Commission emphasises the need for the establishment of a comprehensive monitoring system to form a knowledge base for coherent actions in the future". It also indicates that the actions planned in the near future to address soil protection "are based on existing information, which is recognised as incomplete". It further adds that the monitoring system for soil protection should be established based on "the existing information system, database and know-how. The principles of cost-effectiveness will be taken into account".

The Communication distinguishes two types of monitoring: general and specific. According to the Communication:

- **General monitoring** will give information on the extent and the evolution of existing widespread threats and will provide the basis for policy development to respond more fully and accurately to them. In this way monitoring can become a driving force for policy adjustment and revision for the benefit of soil protection; and,
- **Specific monitoring** will focus on local scale threats and their driving forces and lead to action in sectors which are the original source of soil degradation, thus focusing on the elimination, particularly of contamination at its source. An example would be focused soil monitoring close to industrial plants or highways.

The Commission plans to propose legislation on a Community information and monitoring system for soil threats by June 2004. This monitoring system will provide the basis for future legislative initiatives and will be used as a tool to adjust and review existing policies in the field of soil protection.

Soil monitoring systems already operate in many EU countries, e.g. Austria, France, Finland, the Netherlands, Sweden and the UK. Recently France, based on the monitoring system for forest soils, established a nation-wide soil quality monitoring network, which is the only monitoring system in Europe developed for purposes other than soil protection. However, this system covers a number of soil aspects. The monitoring system is restricted to forests, according to the Council Regulation No. 3528/86 on the Protection of Forests against Atmospheric Pollution.

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[68] Commission of the European Communities 2002a: *Communication from the Commission to the Council, the European Parliament, the Economic and Social committee and the Committee of the Regions: Towards a Thematic Strategy for Soil Protection*. COM(2002) 179 final. Brussels: European Commission. For more information see: (http://www.europa.eu.int/comm/environment/soil/index.htm).

[69] Commission of the European Communities 2002c: *DG Environment Working Document on the Proposal for Organisational Layout for the Work Plan on Soil Protection 2003-2004.* Brussels: European Commission.

[70] Commission of the European Communities 2002a: *Communication from the Commission to the Council, the European Parliament, the Economic and Social committee and the Committee of the Regions: Towards a Thematic Strategy for Soil Protection*. COM(2002) 179 final. Brussels: European Commission. Section 8.3.

At the European level, the European Environmental Information and Observation Network was established to assist the European Environment Agency in producing policy-relevant information on Europe's environment through the delivery of relevant national data. EIONET is a network of national environmental information networks among others currently focusing on soil, contaminated sites and land cover regarding soil issues. The European Topic Centres (ETCs) act as EEA contractors, co-ordinating activities in their thematic areas. Currently there are five ETCs, namely on Air and Climate Change, on Nature Protection and Biodiversity, on Terrestrial Environment, on Water, and on Waste and Material Flows.

The European Topic Centre on Terrestrial Environment technically supports the EEA in the implementation of the soil monitoring and assessment framework through the maintenance and further development of databases and information for use in indicator development and reporting on soil and land issues. In particular, it carries out assessments of past trends, current states, prospective development of soil quality, and degradation. A core set of soil related indicators are being developed in the domains of soil sealing, soil erosion, local and diffuse contamination as main soil issues.

In 2000, co-funded by the European Commission, the European Environment Agency and the Joint Research Centre (JRC) launched a three-year joint project I&CLC2000.[71] I&CLC2000 (IMAGE2000 and CLC2000) project aims for the updating of the European Land Cover database (CORINE Land Cover) as a snap shot of Europe for the year 2000 (CLC2000), using the necessary satellite coverage to create the multi-purpose spatial reference of Europe (IMAGE2000). I&CLC2000 is co-managed by the EEA and the JRC, where JRC is responsible for the link with the European Commission Services and the management of IMAGE2000 and EEA is responsible for the link with participating countries and the management of CLC2000. The project is initiated for the Member States, and extended to accession countries in 2001. The project currently covers 26 countries.

In addition, the land use/cover statistical survey LUCAS was a pilot survey developed by Eurostat and carried out throughout Europe during 2001. It aims to collect data on land use, land cover and environmental features such as erosion and natural hazards.

One major problem for the assessment of soil condition in Europe, based on previously existing data, is the lack of harmonised methodologies for monitoring and data transfer, leading to a lack of comparability of the data.

5.5.2 Reporting

At this time, there are no reporting obligations at the EU level solely addressing soil issues. However, the assessment of soil conditions is at the responsibility of the different European countries.

To report on the state of soil, an indicator[72] based reporting system has been proposed by EEA.[73] On a short-term basis, preliminary indicators for soil erosion, sealing and local soil

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71 See also http://image2000.jrc.it/.

72 For EEA a "soil environmental indicator" is a well selected piece of numerical information that describes an aspect of DPSIR chain applied to soil and that may steer action'. In general indicators quantify information by aggregating different and multiple data. The scope of indicators is intended to simplify information to describe complex phenomena. (DPSIR policy relevant indicators, Driving

contamination issues have been defined and calculated based on available data.[74] On a long-term basis, European soil indicators will be defined for the issues of soil erosion and diffuse soil contamination. These indicators will rely on sound monitoring data. The importance of long-term indicators was underlined. Taking into account that building-up a soil monitoring system will take several years, short-term indicators can only be based on the existing data. Therefore these four indicators are given precedence for a comprehensive European soil monitoring and assessment framework.

A first tentative list describing high-priority indicators related to major soil problems was developedby EEA.[75] The next steps will be:[76]

- Analysis of data needs and selection of indicators according to relevance and practicability;
- Assessment of data needs and identification of data sources; and,
- Elaboration of an EIONET[77] data exchange module or questionnaire with the objective of receiving data from a national database.

5.6 PRESENT LINKAGE BETWEEN EARTH OBSERVATION AND THE SPI

The OECD, the United Nations, Eurostat, the EEA and the European Commission have developed different indicator concepts addressing environmental issues at an international level. Issues considering soil protection and relevant indicators have not been a primary concern and only recently were included in the political agenda.

A first tentative list of relevant indicators on soil as a tool for organising environmental information and for presenting causal links between environmental indicators to policy decision makers has been elaborated by the European Environmental Agency.[78] The indicators are

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Forces, Pressures, State, Impact and Response). See: European Environment Agency (EEA) 2001b: *European soil monitoring and assessment framework*. EIONET workshop proceedings. Technical Report 67, prepared by Sigbert Huber, Alexandra Freudenschuß and Ulrike Stärk. Copenhagen.

73 European Environment Agency (EEA) 2001b: *European soil monitoring and assessment framework*. EIONET workshop proceedings. Technical Report 67, prepared by Sigbert Huber, Alexandra Freudenschuß and Ulrike Stärk. Copenhagen.

74 This statement draws on the following reports: 1) European Environment Agency (EEA) 2000: *Environmental Signals 2000*. Environmental Assessment Report No. 6, European Environment Agency Regular Indicator Report. Copenhagen. 2) European Environment Agency (EEA) 2001a: Proposal for a European soil monitoring. Copenhagen. 3) European Environment Agency (EEA) 2001a: *Towards agri-environmental indicators. Integrating statistical and administrative data with land cover information*. Topic report No. 6. Copenhagen.

75 European Environment Agency (EEA) 2001a: *Towards agri-environmental indicators. Integrating statistical and administrative data with land cover information*. Topic report No. 6. Copenhagen: European Environment Agency.

76 European Environment Agency (EEA) 2001a: *Towards agri-environmental indicators. Integrating statistical and administrative data with land cover information*. Topic report No. 6. Copenhagen: European Environment Agency.

77 European Environment Information and Observation Network (EIONET). For more information see: http://eionet.eu.int/.

78 A table of possible indicators Annex II of this document.

still in the development phase and the aggregation level for different aims should be defined. Annex II provides an example of land cover and environmental stress indicators, focusing on soil erosion and soil sealing issues.

Currently EO services are used in some cases to monitor single issues related to soil, but there is no general approach. The reason for that might be the fact that no soil directive currently exists.

The SPI by itself does not address the issue of EO services. It simply outlines the issue of monitoring.

The potential user group for EO data on soil may include:

- The general public, according to the Aarhus Convention (see chapter 6.2);
- Authorities undertaking monitoring programmes;
- Parties taking part in the policy making process, like the Commission itself, national governments or local authorities;
- Research institutes (e.g. modelling);
- Spatial planners; and,
- Farmers.

5.7 SYNTHESIS: SOIL & EARTH OBSERVATION

Soil performs a number of key environmental, social and economic functions. Agriculture and forestry are dependent on soil for the supply of water and nutrients, and for root fixation. Soil also performs storage, filtering, buffering and transformation functions. It plays a central role in water protection and the exchange of gases in the atmosphere. It is also a habitat and gene pool, an element of the landscape and cultural heritage, and a provider of raw materials.

Many EU policy areas are of relevance to soil (Environment, Agriculture, Regional Development, Transport, Development and Research) but there is generally no main focus on the protection of soil. By introducing the Soil Protection Initiative, a political commitment will be established and soil protection will be achieved more fully and systematically in the coming years. For the long term, it will be necessary to establish a legislative basis for soil monitoring so that a knowledge-based approach may be established, aimed at delivering soil protection.

The main forces currently restricting delivery of soil protection are gaps in spatial data, a lack of meta information, incompatibility of both data sets and software used, and barriers in sharing and re-using spatial data due to cultural, institutional, financial, and legal issues. EO based geo-information could contribute to a great extent, providing spatial information on soil as well as on its pressures. Furthermore, EO services could support the fulfilment of future reporting obligations.

By introducing the issue of EO-services and its possibilities into the Working Group on Monitoring of the SPI, such services could support the preparation process of the monitoring legislation.

A particular benefit of EO based services for soil relates to their ability to contribute to a harmonised data collection. By delivering comparable data in a timely and cost-effective way,

EO services offer the possibility to remedy the current problems related to the assessment of soil conditions in Europe.

Main services that space-based EO could provide are:

- Land use data;
- Land cover data;
- Soil erosion; and,
- Soil sealing (as a part of land use and cover).

This information will not only be relevant for soil protection, but will also be relevant for other issues, like spatial planning or agriculture.

As the Soil Protection Initiative is still in its infancy, the specific indicators and parameters that will measure soil derogations are still being discussed, especially with regard to the issue of soil sealing and soil erosion. EO service providers should enter the discussion and support the development of applicable reporting standards by outlining the benefits that the involvement of EO could provide.

6 OTHER RELEVANT EU POLICIES

Apart from the WFD and the Soil Protection Initiative, there are other EU policies which might be relevant in the Global Monitoring for Environment and Security (GMES) context. In particular, information and reporting policies might have an influence on the demand for Earth Observation data. This chapter outlines the current trends in EU policy making regarding public information and reporting requirements.

Public information and public participation are increasingly seen as vital to good governance on the international as well as on the European level. The need to "connect Europe with its citizens" is recognised,[79] while greater transparency, openness and accountability in policy-making is called for in order to increase trust and confidence of the public in European institutions. In particular, the right of access to information and justice in environmental matters as a prerequisite for citizens to effectively protect the environment has been anchored in international and European legislation.[80] In parallel, reporting obligations of Member States are being reformed.[81]

These policies are likely to increase information flows and data requirements and might thus enhance the demand for EO products. Therefore, they will be presented briefly in the following paragraphs.

6.1 MARINE PROTECTION

The Water Framework Directive covers mainly surface, ground and coastal waters but not marine waters as a main target. With the aim of initiating a multi-stakeholder process, the European Commission published in 2002 a Communication “Towards a strategy to protect and conserve the marine environment” to the Council and the European Parliament.[82] The Commission’s intention is to develop the strategy in close co-operation with Member States, the European Parliament, EEA States and Candidate Countries in the various, mainly regional, international organisations engaged in different sectoral aspects of the marine environment and with environmental, non-governmental organisations and different sectoral industry associations. Besides this process there are two main Conventions on marine protection in Europe:

- **Helsinki Convention:** The Convention, which was signed in March 1974 by all the States bordering the Baltic Sea,[83] is intended to abate pollution of the Baltic Sea area caused by discharges through rivers, estuaries, outfalls and pipelines, dumping and normal operations of vessels as well as through airborne pollutants. The Convention entered into force in 1980. Annex I contains a list of harmful substances to which priority should be given by the Contract Parties. The Parties of the Convention have decided to

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79 Commission of the European Communities 25.7.2001: *European Governance, A White Paper*.

80 United Nations Economic Commission for Europe (UNECE) 1998: *Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters*. Aarhus, Denmark, 25 June 1998.

81 Forthcoming Directive on Environmental Reporting.

82 Commission of the European Communities 2002b: *Towards a strategy to protect and conserve the marine environment (COM (2002)539 final) on 2 October 2002.* Brussels: European Commission.

83 Denmark, Germany, Sweden, Estonia, Finland, Latvia, Lithuania, Poland and Russia.

ban the use of a series of hazardous substances (e.g. dichlorodiphenyltrichloroethane (DDT) and its derivatives (DDE and DDD), polychlorinated biphenyls (PCBs) and polychlorinated terphenyls (PCTs)). Relevant to agriculture, the convention contains a list of substances and pesticides which should be minimised or banned as well. Annex III Part 2 regulates in great detail, the prevention of pollution from agriculture; and,

- **OSPAR Convention:** The overall aim of the convention is for the Contracting Parties to take all possible steps to prevent and eliminate pollution and to take the necessary measures to protect the maritime area against the adverse effects of human activities, so as to safeguard human health and conserve marine ecosystems and, when practicable, to restore marine areas which have been adversely affected. The Convention plans for the reduction and phasing out of substances that are toxic, persistent and liable to bio accumulate rising from land-based sources, as well as programmes and measures for the reduction of inputs of nutrients from urban, municipal, industrial, agricultural and other sources. Another main objective for hazardous substances is the prevention of pollution by continuously reducing releases, with the ultimate aim of achieving concentrations, which are near background levels for those substances which occur naturally (e.g. lead, mercury) or close to zero for man-made substances. The OSPAR list of substances of possible concern is a dynamic working list and is regularly revised as new information becomes available.

The application of remote sensing techniques in monitoring marine and coastal waters has shown the potential to provide synoptic data/information for a number of physical and biogeochemical parameters.[84] In this context, EO services could provide the possibility to evaluate eutrophication in large marine and coastal areas.

6.2 AARHUS-CONVENTION

The most influential document with respect to public participation in the area of the environment on the international level is the Aarhus Convention.[85] This Convention acknowledges that protection of the environment and sustainable development cannot be achieved without the involvement of a well-informed public. It endows citizens with the rights of access to information, public participation in decision-making, and access to justice in environmental matters, thus promoting "environmental democracy".

To date, the Convention officially entered into force in October 2001, after ratification by the sixteenth party.

The Aarhus Convention needs to be considered in the context of several preceding provisions on public participation on environmental and human health issues. Perhaps the most famous one is principle 10 of the Rio Declaration in 1992. Principle 10 already contains the requirements of the Aarhus Convention: "*Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held*

[84] European Environment Agency (EEA) 2002b: *Remote sensing's contribution to evaluating eutrophication in marine and coastal waters*. Technical report 79. Copenhagen.

[85] United Nations Economic Commission for Europe (UNECE) 1998: *Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters*. Aarhus, Denmark, 25 June 1998.

by public authorities...". Similarly, Agenda 21 emphasises the need for strengthening the role of major groups as critical to the effective implementation of sustainable development and outlines the different forms of public participation. The rights granted by the Convention apply to the public uniformly, independent of nationality or residency. Special emphasis is put on non-governmental organisations. The Aarhus Convention is comprised of three pillars of public participation:

- Access to environmental information (Article 4 and 5);
- Public participation in decisions (Article 6-8); and,
- Access to justice (Article 9).

The first of these, access to environmental information, is the most relevant in relation to GMES. Public authorities are required by the Convention to make environmental information available to the public upon request (Article 4, (1)). Requests may be refused under certain circumstances, for example if the request is "manifestly unreasonable or formulated in too general a manner" (Article 4, (3)) or if the disclosure of environmental information would disagree with confidentiality provided for by national law (Article 4, (4)).

The Convention also provides for the collection and dissemination of environmental information (Article 5) by requiring the Parties to ensure that public authorities possess and update environmental information that is relevant to their function, and that the public is informed about the type and scope of environmental information held by the authorities. Publicly accessible lists or registers and the identification of contact points are suggested as measures to support the public in seeking access to information (Article 5, (2)b).

The European Community has signed, but not yet ratified, the Aarhus Convention. As one of the signatories of the Convention, the EU is therefore obliged to implement these principles not only in its Member States, but also upon ratification in its own decision-making processes. This has contributed considerably to increased recognition of these principles on the European level, which is also reflected in the recently published White Paper of the European Commission on European Governance. The paper identifies a need for more transparent and understandable decision-making at the EU level, and stronger interaction with the local governments and civil society.[86]

On the European level, significant policy developments have taken place to accommodate the requirements of the Aarhus Convention and prepare for the ratification of the Convention by the EU. The most recent advancement, pertaining to the first pillar of the Aarhus Convention, is the adoption on 8 November 2002 of a new Directive on public access to environmental information,[87] which replaced an earlier directive (90/313/EC) on freedom of access to information on the environment. The Directive entered into force following publication in the Official Journal in February 2003, and Member States are required to implement its provisions in their respective national legislation by 2005.

The new Directive provides that every natural or legal person, regardless of citizenship, nationality or domicile, has a right of access to environmental information held by or produced

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[86] Commission of the European Communities 2001c: *European Governance, A White Paper*. COM (2001) 428 final. Brussels: European Commission.

[87] The European Parliament and the Council 2003: *Directive of the European Parliament and of the council on public access to environmental information and repealing Council Directive 90/313/EEC (2003/4/EC*).

by public authorities. Environmental information includes air, water and soil quality, biological diversity, noise, health and safety implications. Following implementation of the Directive, the applicant may be able to request environmentally significant information from the public authority, such as data collected on emissions or the results of environmental impact assessments. The Directive also obliges the authorities to make, on their own initiative, such information available on electronic databases that are publicly accessible.

The Directive introduces two types of review procedures (an administrative procedure as well as a judicial procedure) to challenge acts or omissions of public authorities in relation to a request for access to environmental information.

6.3 THE (NEW) REPORTING DIRECTIVE

The European system of environmental reporting requirements is currently under review. The Reporting Directive[88] that was adopted in 1991 required Member States to report on the implementation of certain environmental Directives which mainly dealt with water and air quality and waste management. Member States had to send sectoral reports on the implementation of the Directives to the Commission within specified time limits, in most cases every three years. The reports were to be drawn up on the basis of questionnaires or outlines provided by the Commission.

However, the European Parliament has criticised this Standardised Reporting Directive as having failed to achieve its goals[89] and called for new rules on environmental reporting. A proposal for an amendment to the 1991 Directive is being discussed by the European Commission and Member States; its final adoption is expected for 2004.[90] The new Directive will introduce a standard reporting mechanism for all environmental legislation, and it is expected to cover three types of reporting: check on compliance, policy evaluation and state of the environment.

While it remains to be seen how specifically the data requirements will be defined in the new legislation, it is likely to entail a greater need in the Member States for reliable data and continuous monitoring of the environment, and might well increase the EU's reliance on Earth Observation.

6.4 FURTHER RELEVANT POLICIES

Within the EU, there is a wide range on other policies addressing environmental issues that could be of further interests for EO services - for example, the Common Agricultural Policy (CAP) and the Natural Habitats Directive.[91] Both policies outline needs for environmental

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88 The European Parliament and the Council 1991b: *Council Directive 91/692/EEC of 23 December 1991 standardizing and rationalizing reports on the implementation of certain Directives relating to the environment*.

89 European Parliament 2002: *European Parliament resolution on standardising and rationalising reports on implementation of directives on the environment*. Texts adopted at the sitting of Tuesday, 3 September 2002, P5_TA-PROV(2002)09-03.

90 No author 2003: *Eamonn bates Europe: Issue tracker Environment*, in: Environmental Reporting. February 2003.

91 The Council of the European Communities 1992: *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora*. Official Journal L 206, 22/07/1992.

data, which are often very similar or strongly related to one other (e.g. data on land use, land cover).

The portion of the EU budget allocated to the CAP (presently accounting for around half of the EU budget) has grown over the past five decades, as has the globalisation of the world's economy. As a result, the agricultural sector can be held accountable for a large share of the pollution of surface waters and seas by nutrients, the loss of biodiversity and pesticide residues in groundwater. Reforms of the CAP in the 1990s, and measures taken by the sector itself, have brought about some improvements, but more is needed to balance agricultural production, rural development and the environment. In Luxembourg on 26 June 2003 the EU ministers responsible for agriculture agreed to reform the CAP. The reform will strongly change the way the EU supports its farm sector. In the future, the majority of subsidies will be paid independently from the volume of production as it was organised and structured in the past. To avoid abandonment of production, Member States may choose to maintain a limited link between subsidy and production under clearly defined conditions and within strict limits. These new "single farm payments" will be linked to the respect of environmental, food safety and animal welfare standards. Under the acronym MARS (Monitoring Agriculture with Remote Sensing) the Joint Research Centre runs different activities to support the issues related to the CAP with Remote Sensing issues.[92]

The Natural Habitats Directive: EU policy on biodiversity conservation has intensified over the past 10 years. The core instruments are the 1979 Habitats Directive and the 1992 Birds Directive, which together form the basis for a network of protected areas called "Natura 2000": The EC has also developed regulation on the import and export of endangered species and their derivatives, which seek to implement the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Under the Research and Development Framework Program 4, the DG Research funded a project on "Earth Observation for Natura 2000".[93] It clearly outlines the need of customers for more accurately interpreted results on a local scale. It has been noted that EO data has great potential as input for providing indications of changes within Natura 2000 habitats.[94]

6.5 INFRASTRUCTURE FOR SPATIAL INFORMATION IN EUROPE (INSPIRE)

INSPIRE (Infrastructure for Spatial Information in Europe)[95] is a recent initiative launched by the European Commission, developed in collaboration with Member States, Accession Countries, representatives and key stakeholders at the local and regional level. In the European

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This Directive aims to promote the maintenance of biodiversity in the Member States by defining a common framework for the conservation of wild flora and fauna and habitats of Community interest. The Directive further establishes a European ecological network known as "Natura 2000". The network comprises "special areas of conservation" designated by Member States in accordance with the provisions of the Directive, and special protection areas classified pursuant to the Council of the European Communities 1979: *Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds* Official Journal L 103, 25/04/1979.

92 More information is available under http://mars.jrc.it/.

93 Project Reference: ENV4960362, Acronym EON2000.

94 EON2000 Partnership 2000: *Earth Observation for NATURA 2000 Report.* Prepared by the EON2000 under co-ordination of the National Remote Sensing Centre Limited for the European Commission DGXII / Framework IV.

95 See: http://www.ec-gis.org/inspire/ and http://www.inspire.jrc.it/.

Union, governments collect massive amounts of information relating to the environment, particularly at the regional and local level. However, this information is fragmented, as it contains gaps and duplications (see chapter 3).

The key objective of INSPIRE is to make the distributed and harmonised spatial (geographical) information easier and better available for Community policy-making and implementation in a wide range of sectors, starting with environmental policy. It intends to trigger the creation of a European Spatial Data Infrastructure (ESDI) that delivers to the users integrated spatial information services. INSPIRE focuses specifically on information needed to monitor and improve the state of the environment, including air, water, soil, and natural landscape. Therefore it will address technical standards and protocols, organisational and co-ordination issues, data policy issues, including data access and the creation and maintenance of spatial information. It will initially focus on spatial information needed for environmental policies and other policy areas, such as agriculture and transport. INSPIRE therefore aims in the longer term to provide geographic information for the purpose of Community policy-making in a broad range of sectors. EO data and services could play a major role in this process, especially with the issues on harmonising data and generating common standards.

Possible services are, among others, the visualisation of information, combination of information from different sources, as well as spatial and temporal analysis. These services should allow users to find and access spatial or geographical information from a wide range of sources, from the local level to the global level and in an inter-operable way for a variety of uses. Policy-makers and authorities at the European, national and local levels will benefit first, but improved on-line access to public geographical information will also lead to all kinds of practical uses for the general public. Researchers will benefit as well as many types of businesses operating in more than one Member State.

Currently a public internet consultation process on the development of a policy framework for INSPIRE is finalised and the results are under preparation. The main problems in developing such a framework are:[96]

- Common regulation on access to data. Who has access to which data?;
- One single harmonised set of data (content, format, etc.); and,
- Pricing of data.

The potential benefit of EO Services in this process is the provision of one source of information for all European countries. This would reduce the need for contacting different providers and negotiating different conditions of use. The collection of data from one source (i.e. SAGE) should be done in agreement with local, regional, national and international authorities. Moreover, making information available from one source would also ensure the delivery of one unique format of the data, reducing the need for data harmonisation.

[96] Personal communication with Mr Stefan Kleeschulte, European Topic Center Terrestrial Environment, 12 September 2003.

7 SYNTHESIS ON ENVIRONMENTAL EARTH OBSERVATION

By introducing the Environment Action Programme, the EU gave a strategic direction to the Commission's environmental policy over the next decade. It proposes five priority avenues of strategic action: improving the implementation of existing legislation; integrating environmental concerns into other policies; working more closely with the market; empowering people as private citizens and helping them to change behaviour; and taking the environment into account in land-use planning and management decisions.

Based on this, the Commission introduced some new environmental legislation establishing a group of new monitoring requirements.

In November 2001, the ESA Ministerial Council approved a 5-year ESA programme dedicated to Global Monitoring for Environment and Security program. The GMES programme was established by ESA and the European Commission to utilise more effectively the potential of satellite and other environmental monitoring systems to meet end-user requirements. Within this document the possibilities of EO-services to support European environmental polices was proven, using the Water Framework Directive and the recently released Soil Protection Initiative as two examples.

Both of the policies discussed above - the Soil Protection Initiative and the Water Framework Directive - are still in developing or implementation stages, respectively, and thus still offer sufficient integrating scope for Earth Observation.

The implementation process of the WFD is still being elaborated and is constantly under review, whereas many elements of the SPI are still in their infancy. While the indicators and the parameters for measuring the status of water are almost completely outlined, the choice of indicators according to soil are not yet finalised. Information requirements are also still highly undefined. But even in the WFD there are gaps that have to be filled, especially on the issue of establishing appropriate monitoring programs. This presents a chance to expand application of EO data in the context of these policies.

The benefits that can be gained from the use of EO data are already being recognised within the EU. The European Environmental Agency, for example, points out that for monitoring "and cover changes and environmental stress, remote sensing can be used as a tool to provide timely consistent data across Europe".[97] However, there is still scope to influence the final outcome of the policies described above in favour of a more extensive application of EO.

In order to promote the use of EO data in water policy, the WFD Common Implementation Strategy process should be monitored, and possibilities for EO applications should be identified. In the context of the SPI, a great potential for EO lies in the still open discussion on relevant indicators and the final definition of information requirements. Introducing the possibilities of EO services into the new Working Groups established to develop the SPI further on also offers a great potential.

Beside the WFD and the SPI, there are other relevant policy areas that could benefit from EO-services. Two topics in particular are relevant: policies that are related to land use and land cover issues (e.g. agricultural policies, the Nitrate Directive, policies on spatial panning) and policies that are dealing with public access to environmental data (e.g. Aarhus Convention).

[97] European Environment Agency (EEA) 2003: *EEA core set of indicators*. Technical report. Copenhagen.

There are two main issues that are relevant with regard to furthering the policy development process. Firstly, Earth Observation data have to comply with existing standards (e.g. reporting). Secondly, it is crucial that EO data are shown to present additional advantages over other more conventional data which make them preferable in certain circumstances. To overcome objections by policy-makers it must be proven that the use of EO data is economically feasible. They must either be provided at lower prices than the present solutions or deliver “extra” information which will improve the present reporting or satisfy anticipated future reporting requirements. Thus, the current development and review of EU reporting requirements, which are likely to lead to a tightening of data standards, are an important argument in favour of more extensive use of EO in monitoring and reporting.

EO based environmental data - for many different application fields - could share costs and increase efficiency. It could be of use on local, regional, national and global levels supporting a broad range of users, starting from the general public and up to government authorities.

Service providers can contribute to increased co-operation with policy-makers by following the policy processes, anticipating future needs at early stages, and by linking the development of services to the progress and requirements of policies, especially with regard to reporting requirements, monitoring and standardisation.

8 (FUTURE) OPTIONS AND RECOMMENDATIONS

European Governance increasingly strengthens the role of public information and participation in environmental policy and decision-making. Citizens are granted the right to access environmental information, which should enable them to control and supervise the implementation of environmental legislation and to participate actively in the process of environmental decision making. Earth Observation data have the potential to play a prominent role in this context. Presented in a format that is user-friendly and easily accessible, these data could be a valuable tool to inform citizens about the status of the environment. Thus, the public might become an important user group for earth observation data, which could also increase public awareness and support for Earth Observation and space policy in general.

EU environmental policies seem to be shifting from single problem policies (like the Nitrate Directive) to a more holistic view in the form of framework directives. As the WFD exemplifies, there is a trend towards broader approaches, addressing different aspects at the same time and linking different sectors. (e.g. for drawing a river management plan more than 20 other regulations, have to be considered). This development will increase the need for timely and accurate spatial information. Providing such information is one of the strengths of EO services.

In order to convince policy-makers to integrate EO to a greater extent as a solution to information requirements in future policy implementation documents, it is important to raise awareness by providing sound information on the benefits of EO. It needs to be shown in which cases the advantages of EO, such as its potential for spatial coverage and data standardisation, will outweigh the costs in the short and long term. In this context it will be important to address policy makers at two different levels: first, the working level, as the decision on precise methods and techniques for practically implementing policies will be taken at this level. Second, the integrated level at which a common understanding of implementation or standards can be agreed upon.

As this policy review to the SAGE project has outlined, EO can offer significant potential benefits in facilitating a policy's implementation process. This potential should be moved further to the center of attention in future policy development processes. The recent initiation of the project "Geoland", which is placed within the 6th Framework Programme of the EU, already constitutes a promising step in that direction. Being also part of the overall ESA GMES programme, it considers a larger number of policies, thus opening up the political dialogue to a greater audience. The project may thus extend the benefits of SAGE by further contributing to an increased awareness among politicians on the advantages of EO.

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ANNEX I INFORMATION REQUIREMENTS OF THE WATER FRAMEWORK DIRECTIVE

Source: Common Implementation Strategy: Working Group 2.7 Monitoring; Guidance on Monitoring for the Water Framework Directive - Final Version 23 January 2003

Table 5: Information Requirements of the WFD - Biological quality element (QE) for rivers

Aspect/feature	Benthic invertebrates	Macrophytes	Benthic Algae	Fish	Phytoplankton
Measured parameters indicative of QE	Composition, abundance diversity, and presence of sensitive taxa.	Composition, abundance and presence of sensitive taxa.	Composition, abundance and presence of sensitive taxa.	Composition and abundance, sensitive species diversity, age structure,	Composition, abundance and planktonic blooms, and presence of sensitive taxa
Pressures to which QE responds	Mainly developed to detect organic pollution or acidity, can be modified to detect full range of impacts.	Mainly used to detect eutrophication, river dynamics including hydropower effects.	Mainly used as an indicator of productivity. Can be used to detect eutrophication, acidification, river dynamics.	Can be used to detect habitat and morphological changes, acidification and eutrophication.	Used as indicator of productivity/eutrophication.
Sampling methodology	ISO 8265, 7828, 9391 (surber sampler, handnet, grab)	CEN -standard under development	CEN -standard under development	Depending on habitats - nets, electrofisher	Integrated sample (3-4m), depth sampler
Typical sampling frequency	6 monthly/Annual	Annual/6 monthly	Quarterly/6 monthly	Annual	Monthly/Quarterly
Time of year of sampling	Summer and winter. Spring and autumn in Scandinavia.	Mid to late summer.	All seasons/summer and winter. Summer & autumn in Nordic countries.	Varied	Should cover all seasons. Only during ice free periods in Nordic countries.
Methodology consistent across EU?	No	No	No	No	No
Current use in biological monitoring or classification in EU	Austria, Belgium, Denmark, Finland, France, Spain, Germany, Italy, Ireland, Luxembourg, Portugal Netherlands, Sweden, Norway and the UK	Austria, Belgium, France, Germany, Ireland, Netherlands and the UK	Austria, Belgium, France, Germany, Ireland, Norway, Sweden, Finland, Spain, Netherlands and the UK	Austria, France, Belgium, Ireland, Norway and the UK	None
Existing monitoring system meets requirements of WFD?	No	No	No	No	No
ISO/CEN standards	ISO 7828:1985 ISO 9391:1993 ISO 8265: 1988	CEN-Standard under development	CEN-Standard under development	CEN-Standard under development	
Main disadvantages of present methodology	• Methods require adaptation to meet requirements of WFD • Some require specialist expertise to identify to species	• Not commonly used in EU • Lack of information for comparison to reference • Methodology needs to be adapted to incorporate requirements of WFD	• Not commonly used in EU • Lack in information for comparison to reference • Methodology needs to be adapted to incorporate requirements of WFD.	• Requires specialist sampling equipment • High mobility • Horizontal and vertical distribution patters (differs between species)	• Not routinely used in river quality assessment in EU • Not generally present in flowing rivers • High variability requires frequent sampling

Aspect/feature	Benthic invertebrates	Macrophytes	Benthic Algae	Fish	Phytoplankton
	• High substrate-related spatial variability and high temporal variability due to hatching of insects and variation of water flow • Time consuming and expensive • Presence of exotic species in some EU rivers.	quirements of WFD	quirements of WFD. • Difficult to sample in deep rivers • High substrate related spatial variability • High seasonal variation • Requires specialist expertise for species identification		quent sampling • Difficult to establish dose-response relationships due to flow-related variability.
Feasibility of Earth Observation	• no	• only indirectly • in shallow and undisturbed waters only	• no	• no	• partly (algae bloom only)

Table 6: Features of hydromorphological quality elements for rivers

Aspect/feature	Quantity and dynamics of water flow	Connection to groundwater bodies	River Continuity	River depth and width variation	Structure and substrate of the river bed	Structure of the riparian zone
Measured parameters indicative of QE	Historical flows, modelled flows, real-time flow, current velocity	Water table height, surface water discharge	No and type of barrier and associated provision for fish passage	River cross section, flow	Cross section, particle size, presence and location of CWD	Length, width, species present, continuity, ground cover
Pressures to which QE responds	Used to detect impact of water storage, abstraction and discharge on biota, hydropower regulation	Provides information on surface-groundwater relationship	Used to detect impact on upstream migration of fish	Used to detect impact on biota from changing flows and habitat availability	Determines impact on biota from changing habitat availability	Influences structure of banks, provides habitat and shading for biota, filters diffuse runoff
Sampling methodology	ISO standard for current velocity. No common methodology for dynamics	No common methodology	No common methodology	No common methodology	No common methodology	No common methodology
Typical sampling frequency	In-situ, real time	6 monthly, depending on climatology and geology	Every 5-6 years	Annual	Annual	Annual
Time of year of sampling	All year	Winter and summer	varied	varied	varied	varied
Methodology consistent across EU?	No	No	No	No	No	No
Current use in monitoring programmes or for classification in EU	Yes. Belgium, France, Sweden, UK, Finland and Norway	Yes. Belgium, UK	Yes. Belgium, Germany, France	Yes. Belgium, Germany, France, UK and Norway	Yes. Belgium, Germany, France, UK and Norway	Yes. Belgium, Germany, France, Italy, UK
Existing monitoring systems meet requirements of WFD?						
Existing classification systems meet requirements of WFD?	No	No	No	No	No	No
ISO/CEN standards	ISO/TC 113 CEN?TC 318 under development	No	No	No	No	No
Main disadvantages of present methodology	• Not commonly used	• Not commonly used	• Not commonly used	• Not commonly used	• Not commonly used	• Not commonly used
Feasibility of Earth Observation	• No	• No	• Yes, VHR imagery for identification of barriers	• Yes, but only variation of meandering	• No	• Yes, VHR imagery for vegetation cover and land use

Table 7: Features of chemical and physico-chemical quality elements for rivers

Aspect/feature	Thermal Conditions	Oxygenation Conditions	Salinity	Acidification Status	Nutrients
Measured parameters indicative of QE	Temperature	Dissolved oxygen (mg/L and percent sat)	Conductivity, ca concentration	pH, ANC, Alkalinity	TP, TN, SRP, NO_3 + NO_2, NH_4
Pressures to which QE responds	Inflows, water releases, industrial discharges	Organic pollution, industrial discharges	Agricultural runoff, industrial discharges	Industrial discharges, acid rain	Agricultural, domestic and industrial discharges
Sampling methodology	In-situ using submersible probe	In-situ using submersible probe, or sample collection and Winklers titration	In-situ using submersible probe	In-situ using submersible probe, sample collection	Sample collection in field followed by laboratory analysis
Typical sampling frequency	Fortnightly-monthly	Fortnightly-monthly	Fortnightly-monthly	Fortnightly-monthly	Fortnightly-monthly. More frequently during flooding.
Time of year of sampling	All seasons.	All seasons	All seasons	All seasons. Special attention when sea salt or snow melt episodes.	All seasons. Particularly following inflow events. Not during ice cover.
Methodology consistent across EU?	No	No	No	No	No
Current use in monitoring programmes or for classification in EU	All	All	All	All	All
Existing monitoring systems meet requirements of WFD?	Yes	Yes	Yes	Yes	Yes
Existing classification system meets requirements of WFD?	No	No	No	No	No
ISO/CEN standards	Yes	Yes	Yes	Yes	Yes
Main disadvantages of present methodology	• Does not provide long-term indication	• Diel variations may require frequent monitoring • Does not provide long-term indication	• Does not provide long-term indication	• Does not provide long-term indication • May require intensive monitoring following rainfall events	• Does not provide long-term indication • May require intensive monitoring following rainfall events
Feasibility of Earth Observation	• Yes, but surface waters only	• No	• No	• No	• No • Indirect assessment via indicators (i.e. algae bloom)

Table 8: Features of biological quality elements (QE) for lakes

Aspect/feature	Phytoplankton	Macrophytes	Phytobenthos	Benthic invertebrates	Fish
Measured parameters indicative of QE	Composition, abundance biomass (Chla), blooms	Composition and abundance	Composition and abundance	Composition, abundance, diversity and sensitive taxa	Composition, abundance, sensitive species and age structure
Pressures to which QE responds	Eutrophication, organic pollution, acidification, toxic contamination	Eutrophication, acidification, toxic contamination, siltation, river regulation, lake water level, introduction of exotic species	Eutrophication, acidification, toxic contamination, siltation, river regulation, lake water level, introduction of exotic species	Eutrophication, organic pollution, acidification, toxic contamination, siltation, river regulation, hydro-morphological alteration (littoral)	Eutrophication, acidification, toxic contamination, fisheries, hydro-morphological alteration, Introduction of exotic species
Sampling methodology	Integrated or discrete samples in the water column 1-5 sites per lake A number of sampling gears are commonly used such as hand-held bottles or flexible hose	Aerial photography or/and transect sampling perpendicular to the shore line	In-situ observations of occurrence of natural substrate in littoral zone and/or among macrophyte beds and scraping of sub-strata	Qualitative or semi-quantitative hand net or kick-sampling; Ekman grab or core sampling Gear type depends on type of substrate, e.g. submerged aquatic vegetation - dip net; sand and clay - Peterson, Van Veen grabs; mud - Ponar, Ekman grabs	Electrofishing Net captures, several types (e.g. gill nets, trammel net) Trawls Acoustic
Typical sampling frequency	Monthly/ quarterly In Nordic countries 6 times/summer	Yearly (late summer in Nordic countries), in natural lakes every 3-6 years	Varied from several times during the growing season to once a year	Yearly, in natural lakes every 3-6 years Twice yearly in littoral	Depend upon water body physical characteristics and objective, yearly
Time of year of sampling	All seasons, at least twice a year during spring overturn and summer stratification In Nordic countries no sampling during ice coverage. More stations required if high spatial variation.	Late summer, decided through expert judgement	Quarterly/ 6 monthly/ several times during the growing season In Nordic countries no sampling during ice coverage	Early spring and late summer	Late Spring through to early Autumn
Methodology consistent across EU?	No	No	No	No	No
Current use in biological monitoring or classification in EU	Denmark, Finland, Ireland, Netherlands, Sweden, UK and Norway	Denmark, Netherlands, Sweden, UK for conservation and Norway	No	Finland, Netherlands, Sweden and Norway	Finland, Netherlands, Sweden and Norway
Existing monitoring system meets requirements of WFD?	No	No	No	No	No
ISO/CEN standards	Under development	Under development	Under development	Under development	Under development
Main disadvantages of present methodology	• Requires taxonomic expertise for species identification; • High temporal variability requires frequent sampling	• Difficult to sample in deep waters • Not commonly used in EU • Lack of information for	• No standard methods • Lack of information for comparison to reference conditions • Not commonly used in EU	• Not commonly used in EU • Lack of information for comparison to reference • Methodology needs to be de-	• Requires specialised sampling equipment • Methodology needs to be developed to incorporate re-

Aspect/feature	Phytoplankton	Macrophytes	Phytobenthos	Benthic invertebrates	Fish
	• Vertical and horizontal sample profiles required due to spatial heterogeneity	comparison to reference • Methodology needs to be developed to incorporate requirements of WFD	• Methodology needs to be developed to incorporate requirements of WFD	veloped to incorporate requirements of WFD • Time consuming and expensive to analyse	quirements of WFD
Feasibility of Earth Observation	• Algae bloom only	• Yes; VHR imagery operational • Vegetation cover and extent • Species	• No	• No	• no

Table 9: Features of hydromorphological quality elements for lakes

Aspect/feature	Quantity and dynamics of water flow	Residence time	Connection to the groundwater body	Lake depth variation (water level variation)	Quantity, structure and substrate of lake bed	Structure of lake shore
Measured parameters indicative of QE	Inflow and outflow rates. Water level, spillway and bottom outlets discharges (reservoirs), mixing and circulation patterns	volume, depth, inflow and outflow	Lake surface, lake volume	Lake surface, lake volume, lake depth	Grain size, water content, density, LOI, elemental composition, sedimentation rate, sediment age (Cs 137), microfossils in paleo-limnological studies	Length, riparian vegetation cover, species present, bank features and composition
Pressures to which QE responds	Climate variability, flood control, man made activities	Climate variability, man made activities	Climate variability, man made activities	Climate variability, siltation, water use, flow discharges	Siltation	Man-made modifications, erosion, run-off Water level fluctuations in reservoirs
Sampling methodology	Water level gauge, flow meters, and current meters. In situ using scales or submersible probes associated or not to teletransmission	Echo sounding necessary for depth-volume curves, hypsographic curves	Depth-volume curves, hypsographic curves. Water level gauge.	Sonar device (echosounder), phathometer, Transect methodology with metered sounding poles	Core and grab samplers depending on study objectives 3 main sampling types may be distinguished: deterministic, stochastic and regular grid systems	Transects, aerial photography, planimetry
Typical sampling frequency	Weekly/monthly. Hourly/daily (reservoirs)	Every 5/ 10 year, or less frequently if no changes are suspected. Once per year for reservoirs.	variable	Natural lakes: every 15 yr. Reservoirs: variable	Mostly once a year, or less frequently if no changes expected (reference conditions), in polluted lakes every 3rd to 5th year	Every 6 years
Time of year of sampling	All seasons	All seasons, not during ice cover	All seasons	Reservoirs: generally during operational functioning, spring/ begin fall	Usually winter (from ice in Nordic countries)/ summer	Varied. Spring/summer during growing period
Methodology consistent across EU?	Yes, according to other countries practices	No	No	No	No	No
Current use in monitoring programmes or for classification in EU	No/yes (reservoirs)	No	No	No, France, UK, Spain	No	No
Existing monitoring systems meet requirements of WFD?	No	No	No	No	No	No
Existing classification systems meet requirements of WFD?	No	No	No	No	No	No

Aspect/feature	Quantity and dynamics of water flow	Residence time	Connection to the groundwater body	Lake depth variation (water level variation)	Quantity, structure and substrate of lake bed	Structure of lake shore
ISO/CEN standards	Yes, refer to ISO/TC 113, CEN/TC 318	No	No	No	No	No
Main disadvantages of present methodology	• Time consuming and costly	• Time consuming and costly	• Time consuming and costly	• Accurate Hydrographic maps of lakes are rarely available in sufficient detail for ecological analysis even if bathymetric maps are available their accuracy should be checked carefully *	• Paleolimnological examinations are often relative expensive and the result depends on the undisturbed state of the sedimental archive. The preservation of microfossils may vary.	• Methodology needs to be developed to incorporate requirements of the WFD
Feasibility of Earth Observation	• No direct measurements • Monitoring of reservoirs (water level) possible	• No	• No	• No	• No	• Yes, operational

Table 10: Features of Chemical and physico-chemical quality elements for lakes

Aspect/feature	Transparency	Thermal Conditions	Oxygenation Conditions	Salinity	Acidification	Nutrients
Measured parameters indicative of QE	Secchi depth, turbidity, colour, TSS	Temperature	DO,TOC, BOD, COD DOC	Conductivity	Alkalinity, pH, ANC	Total P, SRP, Total N, N-NO3, N-NO2, N-NH4
Pressures to which QE responds	Agricultural, domestic and industrial discharges	Thermal discharges. Water management in reservoirs.	Eutrophication, organic pollution, industrial discharges	Industrial discharges, run-off	Acid rain, industrial discharges	Agricultural, domestic and industrial discharges
Sampling methodology	*In situ* using Secchi disc TSS: field sample collection followed by laboratory analysis Turbidity: *in situ* turbidimeters, nephelometers Colour: *in situ* comparison to Forel-Ule scale or in lab.	*In situ* using thermistor probes or reversing type Hg thermometer	On-line data acquisition; *in situ* submersible probes; field sample collection followed by laboratory Winkler titration	*In situ* using submersible probes	*In situ* measurement of pH with probe. Sample collection followed by laboratory analysis	Sample collection in the field followed by laboratory analysis
Typical sampling frequency	Monthly/ quarterly related to the biological elements sampling periodicity. Fortnightly of monthly during growth season in Nordic countries.	Monthly/ quarterly	Depends on morphological characteristics of lake: daily/monthly, or at the end of stratification periods (late winter if ice cover or late summer.	Monthly/ quarterly. Should be measured during snow melt or heavy rainfall events	Monthly/ quarterly. Should be measured during snow melt or heavy rainfall events	Monthly/ quarterly Fortnightly of monthly during growth season in Nordic countries.
Time of year of sampling	All seasons.	All seasons	All seasons	All seasons	All seasons	All seasons, or mainly during growth season, SRP also measured during late winter in bottom waters
Methodology consistent across EU?	No	No	No	No	No	No
Current use in monitoring programmes or for classification in EU	Yes	Finland, France, Italy, Norway	Finland, France, Italy, Norway Sweden	Finland, Belgium, France, Italy	Belgium, Finland, France, Italy, Norway, Sweden, UK	Germany, Spain, Finland, France, Italy, Ireland, Netherlands, Norway, Sweden, UK
Existing monitoring systems meet requirements of WFD?	No	No	No	No	No	No
Existing classification system meets requirements of WFD?	No	No	No	No	No	No

Aspect/feature	Transparency	Thermal Conditions	Oxygenation Conditions	Salinity	Acidification	Nutrients
ISO/CEN standards	No	No	ISO 5813:1983 DO ISO 5815:1989 BOD_5	Yes	Yes, no standard for ANC	Yes, several ISO standards exist
Main disadvantages of present methodology	• No disadvantages	• May require intensive monitoring for appropriate description of thermal conditions	• May require intensive monitoring following depletion events in stratified lakes	• Does not provide long term information on trends	• None	• Need for standardisation of analytical techniques
Feasibility of Earth Observation	• Only shallow waters • No quantitative measurements possible	• Yes, but only surface temperature	• No • Indirect assessment via indicators (algae bloom)	• No	• No	• No • Indirect assessment via indicators (algae bloom)

Table 11: Features of biological quality elements for transitional waters

Aspect/feature	Phytoplankton	Macroalgae	Angiosperms	Benthic invertebrate fauna	Fish fauna
Measured parameters indicative of QE	Composition, abundance, biomass (biomass as Chl. a), blooms.	Composition, abundance and cover	Composition and abundance	Diversity, abundance and sensitive taxa	Composition, abundance,[98] sensitive species.
Pressures to which QE responds	Environmental pressures such as water temperature, salinity and others have strong influence on phytoplankton composition and abundance; eutrophication; Other impacts affecting nutrient loading	Nitrogen and phosphorus loadings Human exploitation from fishery, aquaculture, tourism, power plants River/land use changes	Nitrogen and phosphorus loadings Human exploitation from fishery, aquaculture, tourism, power plants River/land use changes	Many types of anthropogenic disturbances (i.e :eutrophication, organic pollution and mechanical pollution or sediment disturbance)	Can be used to detect impacts like dams, water regulation measures, lack of natural habitats like rubble beds for spawning etc.
Sampling methodology	Water sampling	Destructive: bottom sampler(hand corer , benthic grabs, etc.) Non-destructive (counts in quadrats or photographic/video methods, including aerial photography for larger species)	Destructive: bottom sampler(hand corer, benthic grabs, etc.) Non-destructive (counts in quadrats or photographic/video methods, including aerial photography)	Destructive: bottom sampler(hand corer, Van Veen grabs, etc.); use 500 micron sieve instead of or together with 1 mm sieve Non-destructive (counts in quadrats or photographic method) Litter bag or leaf pack techniques (in brackish transitional waters?), artificial substrates Use expert knowledge and pilot studies to determine best regional/type-specific sampling design Remote video techniques (ROV, towed sledge) where appropriate Acoustic methods for biogenic structures from a small boat	Fish-Net sampling (stationary: stake net fishery covering full tidal cycle; supported by trap/fixed net fishing and bottom trawls; mesh 8 mm at cod end) Use expert knowledge and pilot studies to determine best regional/type-specific sampling design

[98] Contaminant bioaccumulation and bioassays are not required for monitoring of ecological quality, only composition and abundance of fish fauna required; only relevant for chemical status if Quality Standards are set for transitional water fish.

Aspect/feature	Phytoplankton	Macroalgae	Angiosperms	Benthic invertebrate fauna	Fish fauna
Typical sampling frequency	Seasonal sampling Use expert knowledge and pilot studies to determine best regional/type-specific sampling design	Seasonally preferable At least twice per year (max/min cover) Use expert knowledge and pilot studies to determine best regional/type-specific sampling design	Seasonally preferable Once or twice per year (max/min cover) Use expert knowledge and pilot studies to determine best regional/type-specific sampling design	Preferable every three months At least twice per year Use expert knowledge and pilot studies to determine best regional/type-specific sampling design	Twice per year Use expert knowledge and pilot studies to determine best regional/type-specific sampling design
Time of year of sampling	At times of minimum flow rate (not during spring melt) + in the same tidal phase?	Seasonally preferable At least twice per year (max/min cover) Use expert knowledge and pilot studies to determine best regional/type-specific sampling design	Seasonally preferable At least once per year at max cover Use expert knowledge and pilot studies to determine best regional/type-specific sampling design	During peak growth period; sampling in spring and autumn with several days of sampling each to find growth peak As recommended in OSPAR/HELCOM/ICES guidelines	. Spring and autumn; cover full tidal cycle
Methodology consistent across EU?	No, but consistent among HELCOM and OSPAR countries for Baltic Sea and North East Atlantic BEQUALM scheme under development - phytoplankton ringtests were carried out in the past, however, they do not cover regional specialities and thus cannot replace national ringtests; chlorophyll ringtests are carried out by QUASIMEME)	No, but consistent in Baltic countries (HELCOM Guidelines for phytobenthos monitoring)	No, but consistent in Baltic countries (HELCOM Guidelines for phytobenthos monitoring)	HELCOM/OSPAR Guidelines for macrozoobenthos, to be adapted to transitional waters if necessary; BEQUALM scheme under development	. Use expert knowledge and pilot studies to determine best regional/type-specific methodology
Current use in biological monitoring or classification in EU	Part of national monitoring in different EU countries	Part of national monitoring in different EU countries	Part of national monitoring in different EU countries	Part of national monitoring in different EU countries	Part of national monitoring in different EU countries
Current use of biotic indices/scores	No	No, but ratio of fast-growing opportunistic versus slowly growing perennial species can be used (shifts due to eutrophication)	No	No	No

Aspect/feature	Phytoplankton	Macroalgae	Angiosperms	Benthic invertebrate fauna	Fish fauna
Existing monitoring system meets requirements of WFD?	No	No	No	No	No
ISO/CEN standards **Other standards**	OSPAR JAMP Eutrophication Monitoring Guidelines: Phytoplankton Species Composition; HELCOM COMBINE Monitoring Guidelines *i)* for phytoplankton species composition, abundance and biomass and *ii*) for phytoplankton Chlorophyll a ISO 10260 (1992) for the determination of chlorophyll a	ISO/CEN: No HELCOM COMBINE Guidelines on Phytobenthos Monitoring	ISO/CEN: No HELCOM COMBINE Guidelines on Phytobenthos Monitoring	ISO 7828:1985 (Guidance on handnet sampling of aquatic benthic macro-invertebrates) ISO 9391:1993 (Sampling in deep waters for macro-invertebrates - Guidance on the use of colonization, qualitative and quantitative samplers) ISO 16665 (marine soft-bottom macrofauna; in preparation) HELCOM/OSPAR Guidelines for macrozoobenthos, to be adapted to transitional waters if necessary;	No
Main disadvantages of present methodology	High spatial-temporal variability, occurrence of freshwater, marine and brackish species in varying physiological state (brackish water zone as “graveyard” of freshwater and marine species), high influence of temperature and salinity fluctuations on phytoplankton composition Taxonomic identification can be difficult and time-consuming. Lack of quality assurance protocols	No standardized method except in HELCOM countries Lack of taxonomic detail (looping of tiny species into morphological groups). Lack of quality assurance protocols	No standardized method except in HELCOM countries Lack of taxonomic detail (looping of tiny species into morphological groups). Lack of quality assurance protocols	High spatial-temporal variability Lack of taxonomic detail (looping of tiny species into morphological groups). Lack of quality assurance protocols High taxonomic expertise required. High sampling frequency and high number of samples required due to variability in time and space	The high mobility, occurrence of eurytolerant marine and freshwater fish and of migrating fish species makes it difficult to relate to impacts occurring at the local scale Long life cycles Large sample sizes requirements Long time series needed for reliable accounts on composition and abundance
Feasibility of Earth Observation	• Indirectly via algae blooms	• Yes, for larger species • VHR imagery	• Yes, VHR imagery	• no	• no

Table 12: Features of Hydromorphological quality elements for transitional waters

Aspect/feature	Morphological conditions			Tidal regime Hydrological budget
	Depth variation	**Quantity, structure and substrate of the bed**	**Structure of the transitional zone**	
Measured parameters indicative of QE	Shape of the basin	Grain size Organic content	Vegetation cover Vegetation type	Freshwater inputs Exchange with the ocean Water residence time Metereological variables
Pressures to which QE responds	Hydrological modification Suspended solids Dredging	Mechanical and organic pollution Hydrological modification Suspended solids. Dredging	Land use and modification of hydrology	Modifications of land use Modifications of the marine sandy coasts Outlet modification
Sampling methodology	Echo soundings Remote sensing	Corers	Remote sensing images and field surveys	In situ measurements of water flows
Typical sampling frequency	Once every 5 years	Once every 3 years	Once every 3 years	A complete annual cycle with quarterly samplings, every 3 years
Time of year of sampling	Indifferent	Indifferent	Spring-summer	Seasonal
Methodology consistent across EU?	No	FOLC method	No	No
Current use in monitoring programmes or for classification in EU	No	No	No	No
Existing monitoring systems meet requirements of WFD?	No	No	No	No
Existing classification systems meet requirements of WFD?	No	No	No	No
ISO/CEN standards				
Main disadvantages of present methodology	None	Time consuming laboratory analysis		Expensive instrumentation
Feasibility of Earth Observation	Yes; operational	No	Yes, operational	No

Table 13: Features of chemical and physico-chemical quality elements for transitional waters

Aspect/feature	Transparency	Thermal conditions	Oxygenation	Salinity	Nutrients
Measured parameters indicative of QE	Light penetration & quality	Thermal Profiles along water column	Oxygen profiles	ppt psu	Reactive species and total budgets (N,P,Si)
Pressure to which the QE responds	Resuspension Solids transport by rivers Aquaculture Eutrophication	Climate variables Thermal pollution Provides information on mixing conditions	Organic matter loading Eutrophication Aquaculture	Freshwater and marine water inflows Water hydrodynamics	Nitrogen and phosphorus loading from river discharge, local point and non-point pollution, aquaculture
Sampling methodology	Secchi disc, autographic photometers	Portable electronic equipment Automated on site buoy	Portable electronic equipment Automated on site buoy	Portable electronic equipment Automated on site buoy	Water sampling, followed by laboratory analysis
Typical sampling frequency	Monthly	Daily measurements with on site buoy Monthly controls	Daily measurements with on site buoy Monthly controls	Daily measurements with on site buoy Monthly controls	Monthly
Time of year of sampling	Every month	Daily + Every month	Daily + Every month	Daily + Every month	Every month
Methodology consistent across EU			OSPAR JAMP Eutrophication Monitoring Guidelines: Oxygen		OSPAR Nutrient Monitoring Guidelines
Current use in monitoring or classification programme in EU					OSPAR Nutrient Monitoring Guidelines
Existing monitoring system meets requirements of WFD					
ISO/CEN standards	No	No	No	No	No
Main disadvantages of present methodology	Extreme temporal variability.	Account must be taken of diurnal and seasonal variability.	Account must be taken of diurnal and seasonal variability. Time consuming if not autographical	Account must be taken of the tidal state at the time of sampling.	Time consuming High spatial and temporal variation Antagonistic with phytoplankton and seaweeds biomass
Feasibility of Earth Observation	No Only indirectly via indicators (vegetation, algae bloom)	No Only surface waters	No Indirectly via indicators	No	No Only indirectly, via indicators

Table 14: Features of biological quality elements for coastal waters

Aspect/feature	AQUATIC FLORA		AQUATIC FAUNA
	Phytoplankton	**Macroalgae/Angiosperms (Phytobenthos)**	**Benthic invertebrate fauna**
Measured parameters indicative of QE **As reported in Annex V (1.1.4 and 1.2.4)**	Composition, abundance, biomass, blooms	Composition, abundance, sensitive taxa, cover	Composition, abundance, diversity, sensitive taxa
Pressures to which QE responds	Eutrophication Nutrients discharges, suspended matters, toxic substances	Many types of anthropogenic disturbances (i.e. nutrient loading, fishing, modification of shore and bed structure suspended matter input)	Many types of anthropogenic disturbances (i.e. :eutrophication, organic pollution, mechanical disturbance, physical modification of seabed , sediments dynamics and fishing)
Sampling methodology	Water sampling (plankton net, water samples)	Direct by SCUBA diving or walking in the intertidal: non-destructive (quantitative counts in quadrats or photographic method, semi-quantitative abundance estimation according to defined scale) , destructive (suction or bottom sampler) Indirect: Shipboard sampling using box samplers (grab, corer) Remote sensing surveys (satellite, airborne multispectral or aerial photography) (e.g. density on mudflats) Remote video techniques (ROV, towed sledge) where appropriate	Direct by SCUBA diving or walking in the intertidal: non-destructive (quantitative counts in quadrats or photographic method, semi-quantitative abundance estimation according to defined scale) destructive (suction or bottom sampler) Indirect: Shipboard sampling using box corers, grabs, dredges Remote video techniques (ROV, towed sledge)where appropriate Echo sounding technique (ROXANN) which can be used to measure the extent of biological habitats
Typical sampling frequency	Best: 15 days At least: monthly sampling at standard depths Determine best regional/type-specific sampling design (i.e. maximum and minimum levels)	Seasonally preferable (4 times for year) At least twice per year (max/min cover); regionally different (HELCOM: once per year) Frequency may be less for seagrasses and/or other long-lived species	Seasonally preferable at least during peak growth period As recommended in OSPAR/HELCOM/ICES guidelines once per year (same season) At least twice per year for Mediterranean Ecoregion
Time of year of sampling	Should cover all seasons, with emphasis on bloom seasons. And particular events related (exceptional blooms)	Seasonally preferable (4 times for year) At least twice per year (max/min cover) with timing depending on ecoregion As recommended in OSPAR/HELCOM/ICES guidelines(once per year, June-September)	Seasonally preferable at least during peak growth period
Methodology consistent across EU?	No but consistent across NE Atlantic and across Baltic Sea (OSPAR and HELCOM Countries)	No but consistent across NE Atlantic and across Baltic Sea (OSPAR and HELCOM Countries)	No but consistent across NE Atlantic and across Baltic Sea (OSPAR and HELCOM Countries)
Current use in biological monitoring or classification in EU	Italy, Norway (partly) , Netherlands, Germany, Sweden (monit), Spain	Norway (partly) Germany (tentative),Denmark, Sweden(monit & class), UK,	Norway (partly), Netherlands, Germany, Spain, , Sweden(monit & class)

Aspect/feature	AQUATIC FLORA		AQUATIC FAUNA
	Phytoplankton	**Macroalgae/Angiosperms (Phytobenthos)**	**Benthic invertebrate fauna**
		Spain	
Current use of biotic indices/scores	Norway	No Spain (Catalonia)	Norway, Sweden UK, Spain
Existing monitoring system meets requirements of WFD?	Generally No Partially in: Italy, Germany, Norway, Sweden	Partially in Germany, Norway, UK, Sweden	Norway, Partially in Germany, Sweden
ISO/CEN standards	No CEN/TC 230 N 0423 in preparation	No Rocky shore ISO standard in preparation (Norway standard 9424):	National Norwegian soft bottom standards (ISO in preparation: TC 230/SC 5: ISO/TC 147/SC5 N350) In preparation ISO16665
Main disadvantages of present methodology	High spatial-temporal variability requires frequent sampling and good spatial coverage Consistent identification requires consistent training and quality assurance procedures as well as inter-calibration Taxonomic identification can be difficult and time-consuming	Require certified and skilled divers Not standardised method Lack of taxonomic detail (looping of tiny species into morphological groups) Consistent identification requires consistent training and quality assurance protocols	Lack of taxonomic detail (looping of tiny species into morphological groups) Consistent identification requires consistent training and quality assurance protocols Require certified and skilled divers
Feasibility of Earth Observation	Yes Extent, density Algae bloom	No Only indirectly via indicators	No

Table 15: Features of hydromorphological quality element in coastal waters

Aspect/feature	Morphological conditions			Tidal regime	
	Depth variation	**Structure and substrate of the coastal bed**	**Structure of the intertidal zone**	**Direction of dominant currents**	**Wave exposure**
Measured parameters indicative of QE	Topography of the type of water body	• Grain size • Solid rock • Other general characteristics: coarse description (mud, sand, gravel, hard soils or rocks sedimentological structures (ripples, sand reefs, under water dunes etc.) • bioturbation, lamination in sediment cover, oxigenation conditions in sediments	• Rock type , form and exposure to waves, • Grain size • Distribution of biological communities • H/L tide levels • erosion/deposition	Water mass movements (speed and direction)	Water mass movements (wave, wind, Fetch-index) frequency of storms directions H/L tide/surge levels
Pressures to which QE responds	Landfill, dredging, dumping, and natural large scale bottom dynamics	Mechanical disturbance and variation in structure and substrate composition due to anthropogenic input	• Mechanical disturbance and variation in structure and substrate composition due to anthropogenic input • Change in macroalgal composition due to chemcial inputs. • diking • beach nourish	Natural modification (mechanical and climatic) of coastline Anthropogenic modifications (constructions)	Natural modification (mechanical) of coastline climate constructions
Sampling methodology	Echo soundings ROV	Corers Scanning acoustic techniques Diving Video	• Skindiving , photo, corer (intertidal soft bottom) • Remote imaging (satellite airborne systems); • Viewpoint photography; In-situ measurements along transects	Drifters, in situ measurements, autographic instruments, Doppler Historical flows data , modelled flows (mainly large scale)	In situ measurements, autographic instruments, Fetch calculations Calculations (mainly large scale) from maps and meteorological data modelling gauging
Typical sampling frequency	Once every 5/6 years Before and after significant pressure applied	Once every 5/ 6 years Sampling “ad hoc”for specific reasons (i.e. construction, benthic studies support)	Once /twice every 5/ 6 years Sampling for specific reasons (i.e. construction, mapping)	Annual cycle.	Annual cycle.
Time of year of sampling	Indifferent Important if seasonal variations in nearshore areas	Indifferent	Summer (to avoid winter with possible ice cover) and if using biological communities	Annual cycle	Annual cycle

Aspect/feature	Morphological conditions			Tidal regime	
	Depth variation	**Structure and substrate of the coastal bed**	**Structure of the intertidal zone**	**Direction of dominant currents**	**Wave exposure**
Methodology consistent across EU?	No	No	No	No	No
Current use in monitoring programmes or for classification in EU	Used in operational monitoring, but not continuously in most of the countries	Italy Sweden (in connection with benthic studies)	UK - SAC monitoring programme		
Existing monitoring systems meet requirements of WFD?			Partially for UK		
Existing classification systems meet requirements of WFD?					
ISO/CEN standards					
Main disadvantages of present methodology	• None	• Time consuming laboratory analysis	• Time consuming laboratory analysis for sediment characterisation • Mapping can be expensive	• Expensive instrumentation.	• Expensive instrumentation
Feasibility of Earth Observation	• Yes; operational	• No	• Yes; operational	• Yes; SAR technology	• Yes; SAR technology

Table 16: Features of chemical and physico-chemical quality element for coastal waters

Aspect/feature	Transparency	Thermal Conditions	Oxygenation Conditions	Salinity	Nutrient conditions
Measured parameters indicative of QE	Light penetration & quality	Temperature Water column structure structure (in stratified waters)	D.O. concentration O2 percent saturation	ppt psu	NO3, NO2, NH4, P04, Si concentration, total N, total P
Pressures to which QE responds	Nutrient surplus (plankton enrichment). Organic matter pollution (sewage, sludge) Particulate load Land runoff Riverine discharges	Thermal point source pollution Thermal alteration due to reduced water exchange and modified dynamics by coastal constructions Climatic changes	Organic pollution, anthropog. enhanced productivity Reduced water exchange by human impacts .	Freshwater runoff. Mixing condition and origin of the water masses Reduced water exchange by human impacts	nutrient surplus,,organic pollution (sewage, sludge) Land runoff Local point and diffuse source inputs Atmospheric input (especially N)
Sampling methodology	Secchi disc, autographic photometers	Autographic instruments CTD	Autographic instruments, or water sampling deployed automatic systems	Autographic instruments CTD	Water sampling, followed by laboratory analysis. Autographic instruments (experimental)
Typical sampling frequency	Best: every 15-30 days At least seasonal	Best: every 15-30 days At least seasonal	Best: every 15-30 days At least seasonal	Best: every 15-30 days At least seasonal	Best: every 15-30 days At least seasonal
Time of year of sampling	All year round	All year round	All year round	All year round	All year round
Typical "sample" size	Single measurement or water column profile.	Water column profile. deployed automatic systems	Water column profile. deployed automatic systems	Water column profile. deployed automatic systems	Single sample, or water column profile. deployed automatic systems
Methodology consistent across EU?	No	No	No but consistent across NE Atlantic and across Baltic Sea (OSPAR and HELCOM Countries)	No	No but consistent across NE Atlantic and across Baltic Sea (OSPAR and HELCOM Countries)
Current use in monitoring programmes or for classification in EU	Italy, Sweden, UK, Denmark, Spain (Basque Country)	Italy, Sweden, Norway Germany, UK, Denmark, Spain (Basque Country)	Italy, Sweden, Norway Germany, UK, Denmark, Spain (Basque Country)	Italy, Sweden, Norway Germany, UK, Denmark, Spain (Basque Country)	Italy, Sweden, Norway Germany, UK, Denmark, Spain (Basque Country)
Existing monitoring systems meet requirements of WFD?	No Spain (Basque Country)	No Partiallly for UK and Norway Spain (Basque Country)	No Partiallly for UK and Norway Spain (Basque Country)	No Partiallly for UK and Norway Spain (Basque Country)	No Partiallly for UK and Norway Spain (Basque Country)
Existing classification system meets requirements of WFD?	No	No	No Norway	No	No Norway
ISO/CEN standards	No	No	Norway	No	Norway
Main disadvantages of present methodology	• High temporal variability	• None	• Time consuming if not autographical	• None	• Time consuming
Feasibility of Earth Observation	• No	• No	• No	• No	• No

Aspect/feature	Transparency	Thermal Conditions	Oxygenation Conditions	Salinity	Nutrient conditions
tion		• Only surface temperature	• Only via indicators (algae bloom)		• Only via indicators (algae bloom)

ANNEX II INDICATOR APPROACHES FOR SOIL SEALING & EROSION - STATE OF THE ART

Source: adapted from European Environment Agency (EEA) 2001a: *Towards agri-environmental indicators. Integrating statistical and administrative data with land cover information*. Topic report No 6. Copenhagen: European Environment Agency., United Nations Environmental Programme (UNEP) 2000: *Guidelines for Erosion and Desertification Control Management with Particular Reference to Mediterranean Coastal Areas*. Mediterranean Action Plan (MAP), Priority Actions Programme (PAP).; Umweltbundesamt (UBA) 2001: *Methodenvergleich zur Datengewinnung und -nutzung im Bereich des Bodenschutzes, Texte 38/01*. Forschungsbericht 299 71 236, UBA-FB 000150. Berlin.

Table 17: Preliminary[99] list of priority indicators for soil erosion

Information Requirement (issue/question)	Indicator	Measurement unit	Preferred time of sampling	Observation technique
Environmental data:				
Soil type	vegetations types, vegetation mass/growth rate/vitality /cover or deviation from ripeness of agricultural crops	Classified	Spring Summer Autumn	Hyperspectral; Not directly but via vegetation indicators; Support of terrestrial surveys by detection of heterogeneities
Soil texture (grain size)	vegetations types, vegetation mass/growth rate/vitality /cover or deviation from ripeness of agricultural crops	---	Spring Summer Autumn	terrestrial
Geology	Soil texture, stratigraphy, lithology	---	Any	SAR, Optical Detection of faults, lines, structures (operational)
Hydrology and hydrography	Irrigation schemes and practices Depth of ground-water table or a non leaky soil layer.	---	Any	SAR & optical
Interrill erosion by overland flow	Differences in soil colour	---	Spring Summer Autumn	Operational Optical systems
Total soil loss by soil erosion (wind erosion)	Field length in the direction of the main wind	t	Spring Summer Atumn	InSAR & optical
Erosion channels	Depth, length	m	Any	SAR & optical
Land use	Land use form (field, pasture, forest, settle-	Classified	Spring	operational

[99] Notwithstanding these examples, there are few other concerning soil erosion. Consequently the approach adopted by the EEA has been to identify the direction of trends of the selected indicators.

Information Requirement (issue/question)	Indicator	Measurement unit	Preferred time of sampling	Observation technique
	ments, traffic areas, mining areas etc.)		Summer Autumn	
Land cover	Vegetation indices (e.g. fruit kind)	percent	Spring Summer Autumn	
Tillage system	Qualitative (conservation or conventional tillage)	---	Spring Summer Autumn	Indirectly via indicators (e.g. agriculture intensity)
Landscape structure elements	Share and length of hedges, tree lines etc.	percent	Summer	VHR optical
Topography (e.g. relief)	Erosive slope length	M	Any	Operational (SAR & optical)
	Relief form type (horizontal curve of the slope)	---	Any	"
	Slope gradient	percent	Any	"
Water balance in soil	Soil moisture, soil colour or deviation from ripeness of agricultural crops	percent	Spring Summer Autumn	(Surface soil moisture only) SAR
Surface water data:				
Impact of soil erosion by water on other media (sediment and element input like nutrients and pesticides in surface water bodies)	Annual suspended sediment load in rivers, annual element loads in rivers	t/a/ha or t/a/km^2	Spring Summer Autumn	terrestrial
Sedimentation areas	Soil colour	---	Spring Summer Autumn	optical
	Vegetation gaps	m^2	Spring Summer Autumn	VHR optical
Climate data:				
Precipitation (rain storm frequency)	Precipitation intensity, amount of precipitation	mm/h, mm	Spring Summer Autumn	terrestrial
Temperature	Temperature (degrees min and max)	°C	Any	Thermal imagery
Evapotranspiration	Evaporation	mm/a	Any	Indirectly via vegetation
Wind	Wind velocity	m/s	Any	Terrestrial
	Wind directions	S-N-O-W	Any	"
	Wind intensities	Degree	Any	"

Table 18: Preliminary[100] list of priority indicators for soil sealing

Information Requirement (issue/question)	Indicator	Measurement unit	Preferred time of sampling	Observation technique
Soil type	vegetations types, vegetation mass/growth rate/vitality /cover or deviation from ripeness of agricultural crops	Classified	Any	Terrestrial Indirectly via indicators / colour
Land use type	Use type	Classes	Any	operational
Sealed area	Surface cover	percent	Any	"
Abandoned land	Ruderal vegetation	---	Summer	supportive
Use intensity	Volume of traffic (in streets, parking places etc.)	---	Any	supportive
Land cover function	Aim of the street (e.g. living street, connecting streets)	---	Any	supportive
Planned use	Use type	---	Any	terrestrial
Urban expansion[101]				
State of urban expansion	Area covered by human settlements and traffic routes	percent	Any	Operational
	Estimated sealed area (by area covered by human settlements and traffic routes) per inhabitant	ha/person	Any	supportive
Increase of urban expansion	Increase in area covered by human settlements and transport network	percent	Any	Operational
High quality/environmentally important soils affected by soil sealing	Portion of high-quality and/or environmentally important soil lost (sealed)	percent	Any	supportive
Total amount of consumption of built-up material	Total consumption of built-up material	t	Any	supportive
	Classified regional settlement structures (presentation as circle diagrams):areas with large conurbation areas where conurbation is beginning to develop rural areas	percent	Any	supportive

[100] Notwithstanding these examples, there are few other concerning soil sealing. Consequently the approach adopted by the EEA has been to identify the direction of trends of the selected indicators.

[101] Urban expansion could be described by the total area covered by human settlements and traffic routes per Member States, perhaps related to the total amount of inhabitants of the Member Sates. If detailed information is available, classified regional settlement structures may be good indicators for the state of urban expansion.

Information Requirement (issue/question)	Indicator	Measurement unit	Preferred time of sampling	Observation technique
Development of human population				
Human population (during a specified time, within a given country)	Total amount of human population	No	Any	Terrestrial
	Population growth rate	percent	Any	"
	Increase in number of households	No	Any	"
Effects of soil sealing on the environment	Number of serious floods / landslides in recent years	No	Any	supportive
Extent of soil sealing in the future	Local activities in defining targets for future soil-sealing rates (increase in area covered by human settlements and traffic routes)	percent	Any	Supportive
Restoration potential of sealed soil (including returning the sealed area to permeable materials)	Local assessments of de-sealing potentials (portion of de-sealable and changeable surface areas (increase or permeability) on the total area covered by human settlements and traffic routes)	percent	Any	supportive
Tourism				
Development of infrastructure in areas highly attractive for tourism	Area covered by human settlements and traffic routes in selected areas (highly attractive for tourism)	No	Any	supportive

ANNEX III LIST OF INTERVIEWED PERSONS

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Maestu, Josefina	Ministry of the Environment, Spain
Marent, Harald	Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management
Rideau, Jean-Pierre	Ministry of Ecology and Sustainable Development, France
Strosser, Pierre	European Commission, Economic Analyses and employment

Further there have been interviews with persons that wished not to be named in this document.

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