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

Guidance Document No. 22
Updated Guidance on Implementing the Geographical Information System (GIS) Elements of the EU Water policy

EUROPEAN COMMISSION

environment

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FOREWORD

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

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

In the context of the above mentioned strategy, a working group dedicated to the development of technical specifications for implementing a Geographical Information System (GIS) for the reporting needs of the Water Framework Directive was established in 2001 under the coordination of the Joint Research Centre. The working group, with the support of most Member States, the Commission, Eurostat and the EEA produced Guidance Document no 9 Implementing the Geographical Information System Elements (GIS) of the Water Framework Directive, which was published in 2003.[1]

Since then, significant changes have been made to the way in which data and geographic information are gathered, reported and shared at the European level and these made it necessary for the Guidance Document to be updated and extended to the needs for EU water legislation and electronic reporting within Water Information System for Europe (WISE). A Drafting Group under the auspices of the WISE Technical Group carried out this task starting in 2007, including a number of consultations with the experts from the Member States through GIS workshops (held in January and November 2008) and via working group on reporting (WG D under CIS) and Strategic Coordination Group. In 2008, an updated WISE GIS Guidance Document was presented to the Water Directors for their approval and endorsement.

We, the Water Directors of the European Union and Norway, have examined and endorsed this updated guidance during our informal meeting under the French Presidency in Paris (24-25 November 2008). We would like to thank the Drafting Group for producing the update and we strongly believe that this and other Guidance Documents developed under the Common Implementation Strategy play a key role in the process of implementing the Water Framework Directive.

We also commit ourselves to assess and decide upon the necessity for reviewing this Guidance Document in the future based on experiences gained during continued implementation of the Water Framework Directive and other water policies of the European Union.

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[1] http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/guidancesnos9sgisswgs31p/_EN_1.0_&a=d

Updated Guidance on Implementing the Geographical Information System (GIS) Elements of the EU Water legislation

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1 Introduction

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

One of the important tools to bring about the common understanding is the development of practical Guidance Documents on various technical issues. In this context, the development of technical specifications for implementing a Geographical Information System (GIS) for the reporting needs of the WFD was begun in 2001 by a working group of representatives of most Member States and the European Institutions under the coordination of the Joint Research Centre. At their meeting under the Danish Presidency (21-22 November 2002) the Water Directors of the EU endorsed the GIS Guidance (Guidance Document No 9)[2] which was published the following year.

After the GIS Guidance was published in 2003, a number of reporting exercises under the WFD and other water directives took place and significant improvements were made to the way in which data and geographic information were to be gathered, reported and shared at the European level.

In 2003, a report on "Reporting for water – Concept document: towards a shared Water Information System for Europe (WISE)" defined the overall concept of WISE which was endorsed by the Water Directors under the Italian Presidency in November 2003[3]. The WFD introduced a new approach to information and data collection and reporting, providing a more streamlined reporting process and a clearer distinction between the needs of different actors and different levels. WISE was to be the system that provided the streamlining and clarity. WISE had to be flexible, easy to be updated, manageable in terms of human resources and descriptive, in that textual information, data, documents, metadata, figures, graphs, maps etc, had all to be incorporated.

In July 2004, DG Environment submitted a proposal for a directive aimed at the introduction of a European spatial data infrastructure (INSPIRE) to encourage harmonisation of geographic data and information exchange leading to streamlined reporting and the common use of geographic information for different environmental policy areas. The directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) entered into force on 15 May 2007[4].

In October 2005, the Environmental Policy Review Group published a vision on reporting and monitoring around the concept of a Shared Environmental Information System (SEIS)[5].

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[2] http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/guidancesnos9sgisswgs31p/_EN_1.0_&a=d
[3] http://ec.europa.eu/environment/water/water-framework/transp_rep/pdf/2003_concept_report.pdf
[4] http://inspire.jrc.ec.europa.eu/
[5] http://ec.europa.eu/environment/seis/index.htm

In order to improve access to environmental information and the availability of reports, the European Commission (DG Environment, Joint Research Centre and Eurostat) and the European Environment Agency (so called Group of Four, Go4) on 24 November 2006 endorsed the WISE Implementation Plan for 2006-2010[6]. On 22 March 2007, the official launch of the public WISE map viewer as "a gateway to water" at the European level took place[7]. WISE serves as a pilot for implementing the INSPIRE directive and the SEIS initiative, and currently is still at its formative phase, developing an electronic data and information system on water that will serve as an exemplar for other environmental sectors.

Following the Common Implementation Strategy for the WFD, streamlining the reporting process for all EU water sector directives (Urban Waste Water Treatment, Nitrates, Bathing Waters and Drinking Water Directives[8]) intensively started in 2007. Other newly adopted (such as the Groundwater Directive[9] and Marine Strategy Directive[10]) and upcoming directives (such as the Directive on Environmental Quality Standards in the field of water policy[11]) will follow the process of the Common Implementation Strategy as regards reporting information on water at the EU level during 2008-2015.

These major steps in the evolution of a system to improve the flow of information, to avoid duplication and to reduce the burden on Member States are described in more detail in Chapter 1.2.

1.1 Purpose of the Guidance

This document aims at guiding experts and stakeholders in the implementation of the Water Framework Directive (WFD) (2000/60/EC) and focuses on the GIS elements which will contribute to the development and understanding of all EU water related GIS reporting requirements under all water directives, as described above, including the River Basin Management Plans as required under Article 13 of the WFD by March 2010 and the revision of reporting arrangements for other water policy areas.

The original GIS Guidance (see above) required updating because of the many changes brought about by the development of the WISE, the practical experience gained from the first 4-5 years of the implementation of the WFD, the technical evolution and the need to adapt to new requirements of SEIS and INSPIRE.

The WISE Steering Group requested members of the WISE Technical Group to do the update during 2007-2008. The WISE GIS community were consulted on the drafts and their comments taken into account. The Guidance is intended not only for those who are responsible for reporting the national information but for those who use and develop it at national and European levels.

The purpose of updating the Guidance is to support the development of WISE by providing guidelines and technical specifications, IT tools, services and digital

6 http://ec.europa.eu/environment/water/water-framework/transp_rep/pdf/wise_ip_2006_2010.pdf
7 http://www.water.europa.eu/
8 http://ec.europa.eu/environment/water/index_en.htm
9 http://ec.europa.eu/environment/water/water-framework/groundwater/policy/current_framework/index_en.htm
10 http://ec.europa.eu/environment/water/marine/index_en.htm
11 http://ec.europa.eu/environment/water/water-dangersub/surface_water.htm

resources to be used by the data providers and WISE developers to ensure satisfaction and availability of water information at the European level for the users.

The revised Guidance is divided into two parts. The first is a set of textual documents describing the general concepts of the GIS requirements in WISE for the WFD and other EU water policy legislation, the types of WISE GIS datasets and the ways in which they are visualised and the principles of compatibility and interoperability. The second part is a set of documents which give more specific, technical details for data specifications, metadata, reference datasets, updating, coding, data exchange and harmonisation. In addition there are a number of Appendices to support and explain the Guidance and a link is provided to digital resources such as XML schemas[12]. The Appendices are living documents in the sense that when new GI layers have been specified, the details will be added to the web-based versions.

1.2 Development of WISE via implementing WFD and other EU-wide reporting on water

The following Chapters describe how WISE has grown in size and technical complexity as the reporting obligations under WISE evolve in accordance with the timetable in the directive and the schedule unfolds for incorporating reporting under other EU water directives. In addition the geographical scope and data content of WISE has increased as the EEA SoE reporting agreements with its member countries becomes fully incorporated.

1.2.1 Developing reporting obligations under WFD

The Water Directors of the European Community and Norway, at an informal meeting in Paris 23-24 October 2000, identified the following elements (*inter alia*) of a Common Implementation Strategy for the WFD[13]:

- The necessity to share information between Member States and the Commission;
- The need to ensure coherence between the implementation of the WFD and other sectoral and structural policies;
- The need to ensure coherence between the implementation of the WFD and other water directives and process and product oriented directives;
- The need to integrate activities on different horizontal issues for the effective development of River Basin Management Plan;
- The need to establish working groups and develop informal guiding and supporting documents on key aspects of the WFD.

During 2003, a Reporting for Water Concept Paper was produced and endorsed by the Water Directors in November 2003. This laid down the various purposes of reporting, i.e. to satisfy the various mandatory and voluntary information needs of the European Commission (in particular DG Environment, DG Eurostat, DG Joint Research Centre, the European Environment Agency and the Commissions and Conventions covering

[12] http://water.eionet.europa.eu/schemas/dir200060ec
[13] http://ec.europa.eu/environment/water/water-framework/objectives/implementation_en.htm

large international rivers and European marine waters). It also described a common vision for information and data sharing and gave the principles for a shared Community data and information management system (the precursor to WISE). The paper identified the need for coherence between the reporting mechanisms and proposed the WFD as a platform for streamlining.

Since 2003, Working Group D (Reporting) has shaped the agenda for reporting under the WISE and has developed the reporting requirements, in the form of Reporting Sheets, for Articles 3 (2004), 5 (2005), 8 (2007) and 13 (2010) of the WFD. The Reporting Sheets, which may be considered as the conceptual models for specific reporting needs, are developed, debated and agreed within the Working Group and the Strategic Coordination Group before formal endorsement by the Water Directors.

Information has already been provided by the Member States for the first three of these reporting requirements and initial compliance assessments have been made for the first two. The reporting exercise for Article 8 (Monitoring Programmes) was the first fully electronic reporting exercise for the WFD and was a great success in terms of streamlining and facilitating reporting. The initial compliance assessment also indicated that good progress had been made and a more detailed assessment is currently underway.

Following agreement on the Reporting Sheets for the River Basin Management Plans, (Article 13), the Reporting Sheets for Articles 3 and 5 were fully reviewed and revised. It is the Commission’s intention to provide a consolidated Reporting Guidance document containing all the Reporting Sheets for the WFD and this is scheduled for approval by the Water directors in November 2008.

The relationship between the Reporting Sheets for WFD Articles 3, 5 and 13 is shown in Figure 1.2.1a (The Reporting Sheets for Article 8 may be considered to be a separate, but interlinked, series).

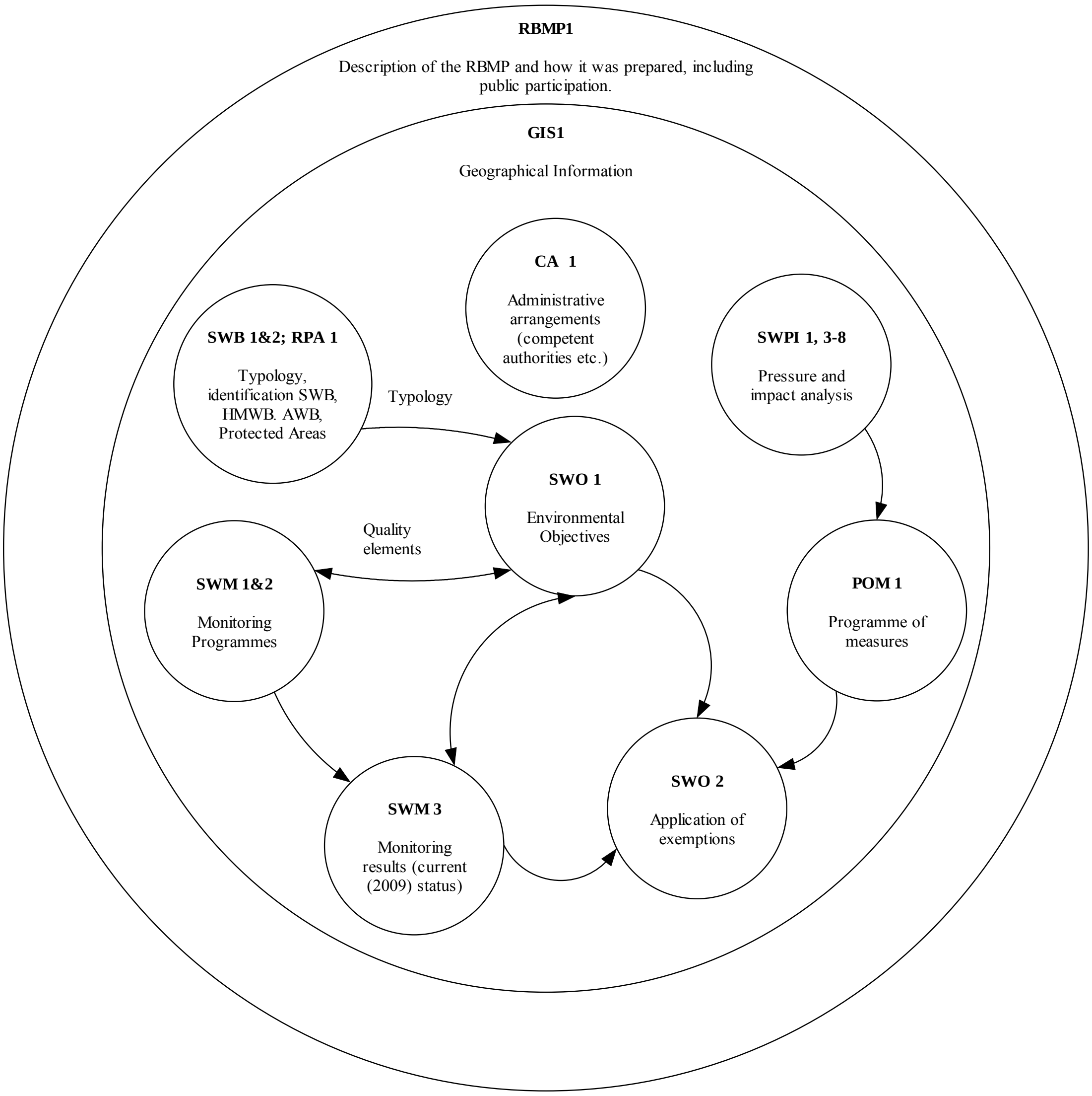

***Figure 1.2.1a Relationship between the WFD Reporting Sheets** (for surface waters only, relationship with groundwaters is virtually the same)*

Following the review, a new, generic Reporting Sheet (GIS 1) was developed to cover all the geographical information requirements for Articles 3, 5, 8 and 13.

Reporting Sheets are converted to logical models and reporting tools in the form of XML schemas which are handled by the Reportnet input tools of the WISE. The new Reporting Guidance will be tested in 2009 in good time for operational use in 2010. The WISE data flows are shown schematically in Figure 1.2.1b. A review period may follow the production of reference datasets.

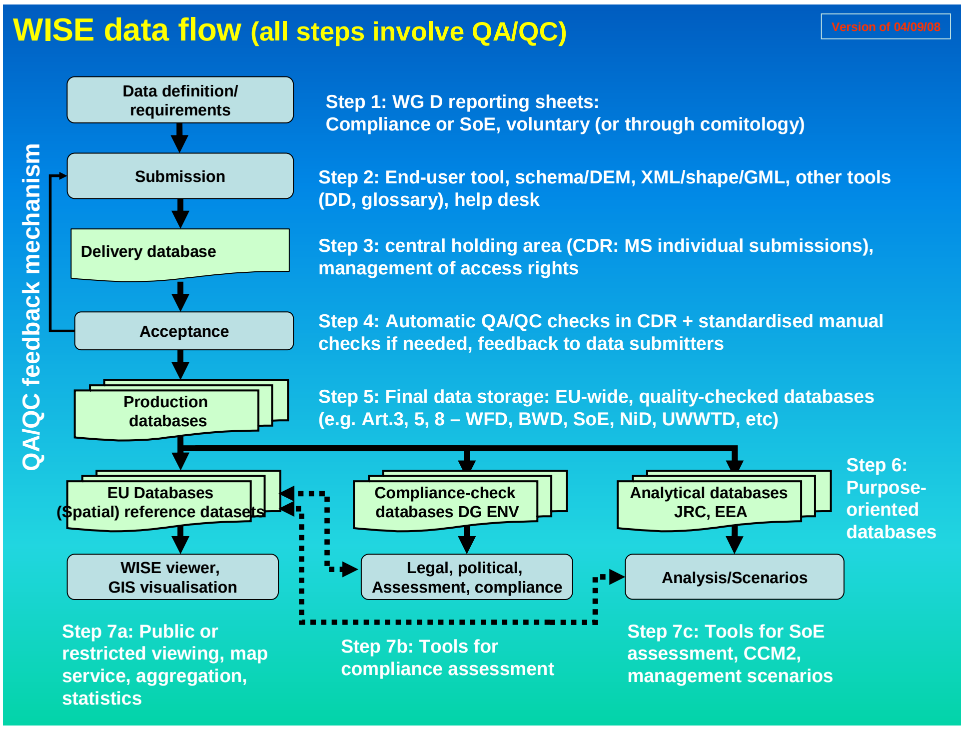

Figure 1.2.1b WISE Data flows

1.2.2 WISE – a system constantly expanding

In 2008, a communication from the Commission to the Council, European Parliament and others (COM(2008) 46 final) laid down the needs for, principles of, costs and benefits of and actions put in place for the Shared Environmental Information System (SEIS). Some of the key principles are:

- Information should be managed as close as possible to its source;
- Information should be collected once and shared with others for many purposes;
- Information should be readily available to public authorities and enable them easily to fulfil their legal reporting obligations;
- Information should be readily accessible to end-users ….. to enable them to assess in a timely fashion the state of the environment and the effectiveness of their policies and to design new policy;
- Information should also be accessible to enable end-users …… to make comparisons at the appropriate geographical scale.

At a horizontal level the INSPIRE Directive (2007/2/EC) establishing an infrastructure for spatial information in Europe entered into force in May 2007.[14] It contains provisions aiming to improve the accessibility and interoperability of spatial data. INSPIRE is based on similar principles to SEIS. Its successful implementation will go a long way towards overcoming existing inefficiencies relating to the usability and use of spatial data stored by public authorities. It is important to recognise,

[14] http://inspire.jrc.ec.europa.eu/

however, that INSPIRE will not directly address data of a non-spatial or non-numerical nature or documents, it will not by itself constitute an integrated e-reporting system related to EU environmental legislation, and will not lead directly to an improvement in the quality and comparability of data. The updated Guidance recognises that the GIS component of WISE will be a building block of the European Spatial Data Infrastructure and will be compliant with the requirements of INSPIRE.

The Global Monitoring for Environmental Security (GMES)[15] initiative aims to provide operational information services based on Earth monitoring data obtained from satellites and *in-situ* observations on water, air and land.

An integrated platform that can link all these initiatives into a shared and common system is required and SEIS aims to provide that function. With the help of Member States this new system will modernise the production, exchange and use of environmental data and information based on the latest information technology.

WISE is seen as the water pillar of SEIS. Although originally designed as a reporting tool in the context of the WFD, WISE is now being extended to integrate reporting data flows from a number of existing and upcoming water-related directives as well as water relevant statistical data. Furthermore, WISE not only relates to the reporting flow but also covers the aspect of information visualisation and dissemination through the WISE map viewer. The overall scale of WISE is shown in the following figure (Figure 1.2.2).

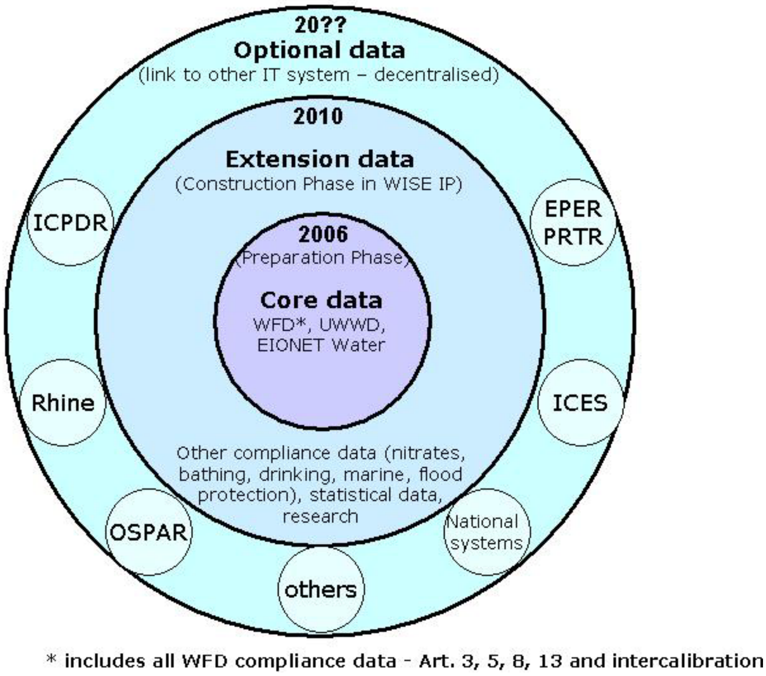

Figure 1.2.2 Planned expansion of WISE

The annual EC Bathing Water Report for the 2007 bathing season (based on Member State submissions under the Bathing Waters Directive) was made available in WISE

[15] http://www.gmes.info/

map viewer in June 2008[16]. A further extension of the functionality was realised in July 2008, when EEA and Microsoft launched a new environmental information portal 'Eye on Earth', displaying the latest information on the water quality in bathing sites across Europe. Through its first application, 'Water Watch', the new portal allows users to rate beaches and to share their comments with others[17].

For the Nitrates Directive, the reporting process through WISE takes place in 2008 and by 2010 should be streamlined with the State of the Environment Reporting (for the EEA via the Eionet). The Reporting Sheets for the Drinking Water Directive were agreed in 2007 and the IT formats are currently being implemented into WISE with the objective reporting through WISE and visualisation of information in 2009.

The Urban Waste Water Treatment Directive (UWWTD) was reported in 2007 and improvements are underway in time for the next reporting cycle in 2009 to use Reportnet as a single entry point of information for WISE. Visualisation of reported data under UWWTD in WISE is already also available through WISE viewer.

Streamlining of reporting on the UWWTD and the requirements for the joint Eurostat/OECD Joint Questionnaire on Inland Waters (JQ-IW) is also being discussed in 2007 by the institutions (Eurostat and DG Environment) and Member States (national contact points on water statistics) and took part in 2008 by aggregating reported data for UWWTD (during the last reporting exercise) to the Member State level and pre-filling this JQ-IW. This process will be further developed in the frame of WISE by making the process more automatic.

The EEA's water data gathering system (Eionet-Water) from its Member Countries (considerably larger than the EU27) has been integrated with WISE and is now called WISE State of the Environment reporting (WISE-SoE). It is based on the Eionet and also has a planned expansion to meet the reporting ambitions of the EEA which is increasingly based on indicators.

In terms of new water policy, the reporting requirements of the Floods Directive have been described in a Floods Reporting Concept Paper and draft Reporting sheets have been produced to meet the needs of the Groundwater Directive. The concept of development WISE –marine part is also under way, and will find its place and the solution in a frame of WISE and other activities related to the marine issues within upcoming few years, with the first deadline on data reporting under the marine strategy directive being in 2010.

The Implementation Plan of WISE[18] describes this progressive expansion and the system design has to be flexible to accommodate the step by step changes.

The WISE is hosted, managed and maintained by the EEA in its capacity as the Water Data Centre based on an agreement between EEA, DG Environment, Eurostat and the Joint Research Centre. Ultimately WISE will be a distributed system and proposals have been made for the design and implementation of the distributed architecture of WISE that take account of INSPIRE guidelines and that the architecture has to be feasible with open source software. The proposed architecture makes a number of

[16] http://ec.europa.eu/environment/water/water-bathing/report_2008.html and http://www.eea.europa.eu/themes/water/status-and-monitoring/state-of-bathing-water
[17] http://www.eea.europa.eu/highlights/heading-for-your-favourite-beach-is-the-bathing-water-clean
[18] http://ec.europa.eu/environment/water/water-framework/transp_rep/pdf/wise_ip_2006_2010.pdf

assumptions: that data from the Member States should be available by both “push” and “pull”; more than one version or format of schemas can be handled; the system is backward-compatible; and countries can use the “old-style” of reporting if they wish. The definition of the service layers is relatively easy but the challenge will be in bringing together different services from all EU Member States and EEA Member Countries. Over the next 2-3 years, a number of Member States/Countries will cooperate with the EEA in exploring the technical options of how to bring that about.

1.2.3 Lessons learned from the first 4 years of WFD implementation

A number of lessons have been learned and these can be divided into five different areas as follows:

(i) The *usage of the WISE portal for reporting data* falls into two phases. In a first phase, the WISE reporting prototype at the JRC was used to store reported data on WFD Articles 3 and 5. While the data reported was stored and a certain level of quality assurance was performed, no European datasets were built at that stage. In a second phase, the reporting of data in accordance with WFD Article 8 and the hand-over of all reported data to the EEA which assumed the responsibility for managing the data marked a major change in procedures. A full quality assurance process was established for Article 8 and the first European datasets were established. Also, the production of GIS reference datasets from the Article 3 submissions on River Basin Districts has begun and, following consultation with Member States, the objective is to have an EU-wide harmonised reference dataset. The reporting as such was moved to the Reportnet system in order to have a common approach across environmental directives, and to use Reportnet as a common data entry point for reporting on water. In a later stage, most probably by 2015, when the reporting formats and data specifications will be in place and fully operational, WISE could be described as a shared and distributed system completely implementing initiative of SEIS.

(ii) In assessing the experiences with *agreed vs voluntary contributions of information* from Member States, the picture is fragmented. Reporting can be regarded as an evolutionary process where experiences have to be collected on both sides: those that do the reporting and those that receive the reports. The history of the Article 3 reporting shows that quality has been improved with the resubmission of data in a second phase. Article 5 data quality, where no resubmission has yet been initialised, suffers from various, non-matching interpretations of the reporting requirements by Member States resulting in heterogeneous data quality and quantity. Also to be taken into account is the improvement of technology e.g. the maturing of GIS systems during the past years which has improved the ability of the Member States to deliver better quality data, as well as making more clear guidelines to harmonise on the technical formats and requirements to report information (in the sense of tabular/point data as well as geographical information) in a uniform way.

(iii) The process of *validating and harmonising data from Member States* has begun with the on-going production of GIS reference datasets. This is a huge task and the available resources on the EU side and on Member States side are not always sufficient enough to lead to a timely production of quality data products. The experiences from the initial years of the WFD reporting are very useful to guide the process on the upcoming Article 13 reporting, which is of key importance in terms of implementing the WFD with a sound data and information base. This process is also serving as a guiding line on reporting and data visualisation process for other EU water directives.

(iv) The *experiences of handling resubmissions of data*, derived from the Article 3 resubmissions, show that this is an important way of improving data availability and data quality. Therefore the opportunity of improving Article 3 and in particular Article 5 data in conjunction with the Article 13 reporting will be strongly recommended. The Article 3, 5 and 13 Reporting Sheets are being amalgamated into a single consolidated Guidance and the associated XML schemas are being streamlined to avoid duplication and reduce the reporting burden on Member States. Also, Article 8 data, which is seen to be especially dynamic (changeable), will be subject to periodical updates. This is an area in which new technologies and distributed system architectures will be initially explored and applied.

(v) The *experience of provision of updated information* is derived from the fact that the Article 3, 5 and 8 data were submitted over a span of years and designed to be interlinked for the purpose of reducing duplication of reporting. The experience has shown that information inevitably changes over even a short time period and the management of versioned submissions is crucial for the correct processing and interpretation of data.

1.3 Terminology and abbreviations

Ambiguity in terms may easily evolve in a period where several related processes are taking place simultaneously in the domain of spatial data infrastructures. It has not been the intention with this document to come up with new definitions of concepts, rather we have strived for alignment with the terminology applied by INSPIRE working groups in order to improve transparency. A part of the INSPIRE terminology has been developed through the elaboration of documents from the INSPIRE Drafting team “Data Definition”. The terminology may however continue to evolve until the INSPIRE process deliver a final glossary to be available from http://www.ec-gis.org/inspire/.

A wider glossary of terms can be found in Appendix 14.

1.3.1 Terminology

In order to avoid ambiguity in terms, it is important to note that the following terminology will be used throughout this document:

Code:

A rule for converting a piece of information (for example the confluence of rivers) into another form or representation, not necessarily of the same sort.

> **A**: a representation of information in a shorter alphanumerical form**.**
>
> EXAMPLE: the two letter ISO 3166 Country code (e.g. DE for Germany); acronyms and abbreviations; ASCII code.
>
> **B:** identifiers with a certain logic for which more than just the simple identification relationship can be derived.
>
> EXAMPLE: Hydrological feature code - A Pfaffstetter code describes the relative position of a river in a river network (see Chapter 5.4).

Feature:

Abstraction of real world phenomena [ISO 19101]. In this document synonymous with spatial object. Unfortunately “spatial object” is also used in the ISO 19100 series of International Standards, however with a different meaning: a spatial object in the ISO 19100 series is a spatial geometry or topology.

Feature type:

Classification of **features**.

> EXAMPLE Cadastral parcel, road segment or river basin are all examples of potential feature types.

> NOTE In the conceptual schema language UML a spatial object type will be described by a class with stereotype <<FeatureType>>.

GIS layer:

Identifiable collection of spatial data produced according to a data product specification, used synonymously with the “spatial data set”.

Identifier:

Linguistically independent sequence of characters capable of uniquely and permanently identifying that with which it is associated (ISO 19135).

Map:

A graphical representation of a section of the Earth's surface. The Water Framework Directive refers to a number of maps, each one with a specific thematic content – a spatial data set (e.g. a map of the River Basin Districts). A map can be made up of one or many GIS layers. Using GIS software, maps can be presented in digital form from which an analogue map can be plotted.

Object:

in this document used as a generic term for abstractions, often represented as either tables or features.

River basin:

The area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth, estuary or delta. (Definition from WFD). A river basin may include sub-basins.

River basin district:

The area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters, which is identified under Article 3(1) as the main unit for management of river basins. (Definition from WFD).

River sub-basin:

The area of land from which all surface run-off flows through a series of streams, rivers and, possibly, lakes to a particular point in a water course (normally a lake or a river confluence). (Definition from WFD).

Table:

Most software systems require the organisation of datasets in one or more tables. In order to make information comparable between organisations, the structure of these tables must be similar. (Definition fromWFD GIS Guidance).

WISE Reference GIS dataset:

Dataset which provides a comparable basis for visualisation or assessment of geo-referenced data across Europe (for more details see Chapter 3.1).

1.3.2 Abbreviations

BWD	Bathing Waters Directive
DWD	Drinking Water Directive
CRS	Coordinate Reference System
CSL	Conceptual Schema Language
EC	European Commission
EEA	European Environment Agency
EGM	EuroGlobalMap
E-PRTR	European Pollutant Release and Transfer Register
ERM	EuroRegionalMap
ETRS89	European Terrestrial Reference System 89
EU	European Union
EUROSTAT	Statistical Office of the European Communities
EVRF2000	European Vertical Reference Frame 2000
ESDI	European Spatial Data Infrastructure
GI	Geographic Information
GIS	Geographic Information System
GML	Geography Markup Language
INSPIRE	INfrastructure for SPatial InfoRmation in Europe
IR	Implementing Rule
ISO	International Organization for Standardization
ISO/TR	ISO Technical Report
JRC	Joint Research Centre
MS	Member State
NiD	Nitrates Directive
OCL	Object Constraint Language
OGC	Open Geospatial Consortium
RBD	River Basin District (according to the WFD definition)
RISE	Reference Information Specifications for Europe

SoE	State of Environment
UML	Unified Modelling Language
UWWTD	Urban Waste Water Treatment Directive
WCS	Web Coverage Service
WFD	Water Framework Directive
WFS	Web Feature Service
WISE	Water Information System for Europe
WMS	Web Map Service
XML	eXtensible Markup Language

CONCEPTUAL CHAPTERS

2 GIS in WISE: developing a common understanding

2.1 Scope of GIS Guidance and purpose of GIS in WISE

This Chapter introduces the general basis for the detailed specifications which are described in the following Chapters. It reflects the common understanding of the Working Group experts (and others) on the purpose and the structure of the GIS elements to be developed as a basis for the reporting obligations under the water policy domain. A common understanding is an essential pre-requisite for a consistent approach to the reporting of spatial information and it had to be achieved on issues such as the contents of the various maps, the scale and positional accuracy of the data, and the reference system and projections to use. Given the fact that the various GIS layers at national or River Basin District level will be part of a European picture, it was necessary to consider issues such as the harmonisation at boundaries and the use of common identifiers. Recommendations are given on the standards to be implemented for data exchange and data access and on the content and structure of the metadata to accompany each layer.

Technical possibilities nowadays allow the required GIS layers to be provided in two different ways. One option is to transfer them into a centralised system, where they will be stored, quality checked and analysed. The other option is to leave them at their place of origin (i.e. to store the data sets locally in each River Basin District or at national level) and to guarantee broad access to these data through common standards and protocols. While the first option is easier to implement and has been pursued as a short-term objective, the second option will reduce the burden of transferring data and the longer-term objective is for the set-up of a decentralised or distributed system and work is currently in progress on that.

In a more general context, it should also be noted that information, consultation and participation are requirements of the Directive, since they will ensure a more efficient and effective implementation. The *Guidance on Public Participation*[19] provides more detail about these forms of participation. In particular WFD Article 14 promotes the active participation of all interested parties in the development of River Basin Management Plans and requires Member States to inform and consult the public. The latter can most efficiently be done through maps, GIS technology and web mapping.

2.1.1 GIS guidance – a necessity for streamlining reporting

Building on the common understanding, further consistency is achieved through the processes of the Common Implementation Strategy where the conceptual aspects of reporting are described in the WFD Reporting Concept report which was developed and agreed by Working Group D (Reporting) and the Strategic Coordination Group (SCG) and endorsed by the Water Directors on behalf of the EU Member States. Detailed specifications were then drafted in the form of Reporting Sheets by a Drafting Group of Working Group D and subsequently discussed and agreed by the main Working Group and the SCG with final endorsement by the Water Directors. The Reporting Sheets were converted into XML Schemas (or other Reportnet tools) which were used by the Member States for their formal reporting to WISE.

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[19] http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/guidancesnos8spublicspar/_EN_1.0_&a=d

For the reasons explained in Chapter 1.2.1 it has become necessary to re-assess Reporting Sheets for reporting the information required under WFD Articles 3 and 5 that were developed over a number of years, in accordance with the reporting deadlines, and to streamline and update them while the reporting for Article 13 (River Basin Management Plans) is under consideration. The task is to produce a streamlined, consolidated Reporting Guidance to Member States (and other WISE users) and gain the endorsement of the Water Directors by the end of 2008. Contemporaneous with this, the XML schemas for Article 13 reporting will be streamlined to allow Article 3 and 5 information to be resubmitted if it is out of date (in accordance with Article 3.9 and Article 5.2) while recognising that if RBMP information has been reported under other directives (see Chapter 1.2.2), it need not be reported again. The aim is to eliminate duplication and achieve the objective of "report once, use many times".

2.1.2 The role of GIS in WISE

Even though only Annex I (Competent Authorities) and Annex II (Surface Waters) of the WFD explicitly state that the respective maps should as far as possible be available for introduction into a GIS, it is obvious that the best way to provide most of the requested information will be in the form of GIS layers. This is due to the fact that most of the data is to be presented in its spatial context and that questions like 'where are the critical areas?', 'how much area is involved?', or 'which points are in a designated area?' can easily be answered when the data are kept in their spatial context and when the background database has the appropriate design.

The provision of (or access to) the requested GIS layers will not only facilitate reporting by the Member States themselves; it will also facilitate the further compilation and analysis of the information as a basis for the Commission's own reporting obligations under the WFD in accordance with the requirements of Article 18. Such development is also in line with current efforts under the INSPIRE (Infrastructure for Spatial Information in Europe) initiative of the Commission and the Member States, aiming at the development of a harmonised European spatial data infrastructure (see Chapter 1.2.2). Many parties are involved in the implementation of the WFD, ranging from local water authorities to the European Commission. Regarding this wide range of parties, having different practices for water management, different reporting obligations and different levels of technical abilities, this Guidance Document strives to keep specifications as simple as possible, based upon standards where feasible, and according to best current technical options.

The agreed Reporting sheets for WFD (Articles 3, 5, 8 and 15) require that Member States report a considerable amount of information in the form of spatial data. This is especially so for the reporting of the River Basin Management Plans where the results of the surface water monitoring programmes have to be reported to enable the following maps to be produced:

- Map 1: Ecological status class of natural water bodies;
- Map 2: Ecological potential class for Heavily Modified Water Bodies;
- Map 3: Status for Protected Areas;

- Maps 4-8: Achievement or exceedance of Environmental Quality Standards for heavy metals; pesticides; industrial pollutants; other pollutants (all from the list of Priority Substances) and, other (national) pollutants.

For groundwater bodies, (or group of Groundwater Bodies), Member States are required to provide the information necessary to produce the following maps:

- Map 1: Achievement/exceedance of good quantitative status;
- Map 2: Achievement/exceedance of good chemical status for nitrates;
- Map 3: Achievement/exceedance of good chemical status for pesticides;
- Map 4: Achievement/exceedance of good chemical status based on national thresholds for other pollutants;
- Map 5: Identification of Groundwater bodies where a significant and sustained upward trend (notifying the relevant substances) has been identified.

The implementation of the WFD therefore requires the handling of spatial data both for the preparation of the River Basin Management Plans and for the reporting to the Commission. In the first case GIS techniques will be essential for the derivation of various information layers (e.g. on the characteristics of river basins and water bodies, on the chemical and ecological status of water bodies and potentials of various management measures), while in the second case GIS will be the tool for the preparation and delivery of the GIS layers required for the reporting.

2.1.3 Member State GIS submissions and WISE Reference GIS datasets

There are two main types of spatial datasets involved in WISE:

- Spatial data submitted by MS according to Directives:
    - Named by the Directive e.g. “WFD River Basin Districts”.
- WISE Reference GIS datasets:
    - Aggregated from MS submissions;
    - Prenfix “WISE” e.g. “WISE River Basin Districts”.

The basic concepts for the GIS layers are as follows:

- All the GIS layers described in this guidance are vector data (point, line or polygon datasets);
- The WISE GIS reference layers are made available through WISE;
- All GIS layers will have associated attribute information which can be accessed as required or used to derive maps;
- In certain circumstances WISE layers are to be made available for download;
- It is the responsibility of the Member States to collect and compile GIS layers conforming to requested precision, quality and content for use within WISE under an agreed format (developed/clarified through recommended guidance for each layer), including metadata and data IT formats to ensure that an EU-wide harmonised layer will be available in WISE;

- It is the responsibility of the EEA and/or third parties to compile and maintain Reference, Background and External GIS layers within WISE;
- It is recognised that for data collection an input scale of 1:250,000 or better should be a common goal;
- All data will be harmonised to enable analysis and subsequent dissemination at the European level using WISE Water Reference and Background / External datasets (which should be provided by the Member States under agreed technical/IT formats).
- It should be noted that a map derived from GIS layers relating to datasets in WISE (e.g. a map of ecological potential) is not a GIS layer in itself as it is based on the attribution of one or more other layers, and is transient over time as that attribution changes or the rules for creating the map change.

2.2 GIS data requested from Member States under WISE

The reporting of spatial information under the water-related directives function as a reference frame for other documentation of the implementation of the directives. The form of reporting has, as a consequence of the Common Implementation Strategy, shifted from specific map products into spatial data that may be further processed in a GIS environment. The table below (Table 2.2) provides an overview of the data layers that have currently been defined and requested for the water-related directives and voluntary agreements.

Table 2.2 is provided as an overview; details can be found in subsequent Chapters, in particular Chapter 5.2 and Appendices 05 and 06.

Table 2.2 Overview of GIS data requested from Member States

Policy area	**Feature group**	**Data layers**
WFD	Management units	River Basin Districts
		Sub-units
		Competent Authorities
		Water bodies categorised by: Lake, River, Transitional, Coastal, and Groundwater
		Drinking water protected areas
		Economically significant aquatic species protected areas
		Recreational waters protected areas

		Nutrient-sensitive protected areas
		Habitats protected areas
		Birds protected areas
	Infrastructure layer	River Basins, Sub-basins
		Main Rivers
		Main Lakes
		Transitional waters
		Coastal waters
		Main artificial waters
		Groundwaters
	Measurement features	Surface water monitoring stations
		Groundwater monitoring stations
	Background features	Eco regions
WISE-SoE	Management units	WISE-SoE Groundwater bodies
	Measurement features	WISE-SoE River stations
		WISE-SoE Lake stations
		WISE-SoE Water quantity stations
		WISE-SoE Transitional, Coastal and Marine water stations
		WISE-SoE Transitional, Coastal and Marine water flux stations
		WISE-SoE Groundwater sampling sites
	Influencing features	WISE-SoE Groundwater saltwater intrusion

UWWTD	Management units	Receiving areas
		Sensitive area – River, Lake Transitional water,, Coastline, Coast area, Catchment
		Less sensitive area – Transitional water; Coastline
	Influencing features	Agglomeration
		Urban waste water treatment plants
		Discharge points

Bathing Water Directive	Management units	Bathing Water
	Measurement features	Sampling points inland and coastal
Drinking Water Directive	Management units	Water Supply Zones
Nitrates Directive	Management units	Nitrate Vulnerable Zones
	Measurement features	Monitoring zones on surface water
E-PRTR	Management units	Location of sites

3 Definition of derived products (maps)

3.1 Types of WISE GIS datasets

There are various types of dataset in WISE:

- **Member State submitted GIS datasets:** these may be relatively dynamic, such as the point locations of monitoring stations. Others may be relatively stable over time, such as UWWT agglomerations, UWWT plants and discharge points from UWWT plants. Datasets may be points as described above or polygons, such as Protected Areas and Nitrate Vulnerable Zones. These datasets may be considered candidate WISE Reference GIS datasets to be further developed in the future;

- **WISE Reference GIS datasets:** these are relatively stable over time. There are currently five WISE Reference GIS datasets. The WISE Reference GIS datasets are created using detailed digital spatial data provided by Member States and other sources, generalised for the purposes of visualisation and assessment of geo-referenced data across Europe. Thematic data can be attached or linked to WISE Reference GIS datasets;

- **Background GIS datasets:** refer to datasets such as administrative borders of the Member States, coastline, main cities/towns and roads. They provide the background and context for mapping the WISE Reference GIS datasets;

- **External GIS datasets:** these can be used to support further analysis and the visualisation of the WISE Reference GIS datasets, such as CCM2, Corine Land Cover and EEA European River Catchments.

All WISE Reference GIS datasets will fulfil standard quality criteria and will be made available to all WISE stakeholders and, wherever possible, made publicly available through official outlets e.g. through the EEA or GISCO.

All WISE Reference GIS datasets will be managed and maintained within WISE by the EEA. Background and External GIS datasets will be maintained by their data owners. Other GIS datasets will be managed and maintained by the EEA water data centre as they become integrated with WISE Reference GIS datasets.

The WISE Reference GIS datasets and the Member State submitted GIS datasets can be categorised into two different application types:

- Hydrological infrastructure layers describe the features of the physical hydrological system, e.g. rivers, lakes and river basins. The hydrological infrastructure layers can respond to questions such as “which areas contribute to flow of water at this point?”

- Water management layers describe the hydrological features from a management perspective that allow the aggregation of features across river basin boundaries, e.g. River Basin Districts and water bodies. The water management layers can respond to questions such as “who is responsible for the water quality in this area?” or “which water features are affected by similar pressures, have a similar status and may be managed in a similar fashion?”

More detailed information on all datasets in WISE can be found in Appendix 05.

3.1.1 WISE Reference GIS datasets

The current WISE Reference GIS datasets are:

- Large Rivers and Large Lakes;
- Main Rivers and Main Lakes;
- Water Bodies;
- River Basin Districts;
- Sub-units.

The River Basin Districts and Sub-units WISE Reference GIS datasets will support the visualisation and analysis of the Large Rivers and Large Lakes, Main Rivers and Main Lakes, and Water Bodies WISE Reference GIS datasets. The Main Rivers and Main Lakes WISE Reference GIS dataset will be the primary reference dataset used to present information at the European scale.

Additional information concerning each WISE Reference GIS dataset is provided in the following Table 3.1.1.

Table 3.1.1 Description of WISE GIS Reference datasets

WISE Reference GIS dataset	Description
1. Large Rivers and Large Lakes	Large Rivers is dataset with two feature types: a) Rivers with a catchment area > 50,000 km^2 and b) rivers and main tributaries that have a catchment area between 5,000 km^2 and 50.000 km^2 Large Lakes are lakes that have a surface area > 500 km^2. Large Rivers and Large Lakes are based on GISCO data at a scale of 1:10,000,000, supplemented by WFD Article 3 submissions. The data set is intended for visualisation only.
2. Main Rivers and Main Lakes	Main Rivers are rivers that have a catchment area ≥ 500 km^2. Main Lakes are lakes that have a surface area ≥ 10 km^2. Main Rivers and Main Lakes are based on WFD Article 3, Article 5 submissions and when needed ERM (EuroRegionalMap) or CCM2 v2.1 have been used to complement the layer.
3. Water Bodies	Water Bodies are based on WFD Article 5 submissions of Surface Water Bodies and Groundwater Bodies. River water bodies have a catchment area > 10 km^2, lake water bodies have a surface area > 0.5 km^2, all transitional and coastal water bodies are included.
4. River Basin Districts	River Basin Districts are based on WFD Article 3 submissions.
5. Sub-units	Sub-units are based on the submission of Sub-units by Member States at the request of the European Commission. Sub-units are defined by the national Competent Authorities of the River Basin Districts for management purposes where the River Basin Districts are very large. Sizes can vary between 5,000 and 50,000 km^2.
6. WISE-SoE stations	WISE-SoE stations are based on Eionet-Water and WFD Article 8 stations. The WISE-SoE stations have a history of more than 10

	years being annually reported and used for EEA SoE assessments.

Details regarding the production of WISE Reference GIS datasets can be found in Chapter 6.2.

3.1.2 Purpose of the WISE Reference GIS datasets

WISE Reference GIS datasets provide the basis against which comparable statistics and indicators are calculated. WISE Reference GIS datasets are based on nationally reported data from the Member States for use at different scales. Features at European, national and regional levels are linked through vertical integration using coding.

The WISE Reference GIS datasets have three main purposes:

- ***Visualisation:*** through the WISE Viewer it is possible to display features reported by Member States, the results of any analysis of the data, or a combination of any information available.
- ***Analysis:*** the data reported by Member States and contained in WISE can be used for analysis and assessment (compliance checking, policy effectiveness, modelling of scenarios for policy development, etc). Indicators can be determined at various levels. They should be produced using methodologies that are robust and transparent in agreement with the Member States.

  The visualisation and analysis of indicators at different scales can be achieved by linking the WISE Reference GIS datasets, either by code or spatially (see Figure 3.1.2a below). At the most detailed level, actual values may be visualised and analysed using the geometry defined for the feature against which the values were reported. Alternatively, reported values may be aggregated to a different spatial unit. For example, heavily modified river water bodies could be visualised and analysed at the individual water body level. Alternatively, a percentage of heavily modified river water bodies within a River Basin District or Sub-unit could be calculated by aggregating values within the spatial unit, or the heavily modified river water bodies could be related to their associated Main River stretch.

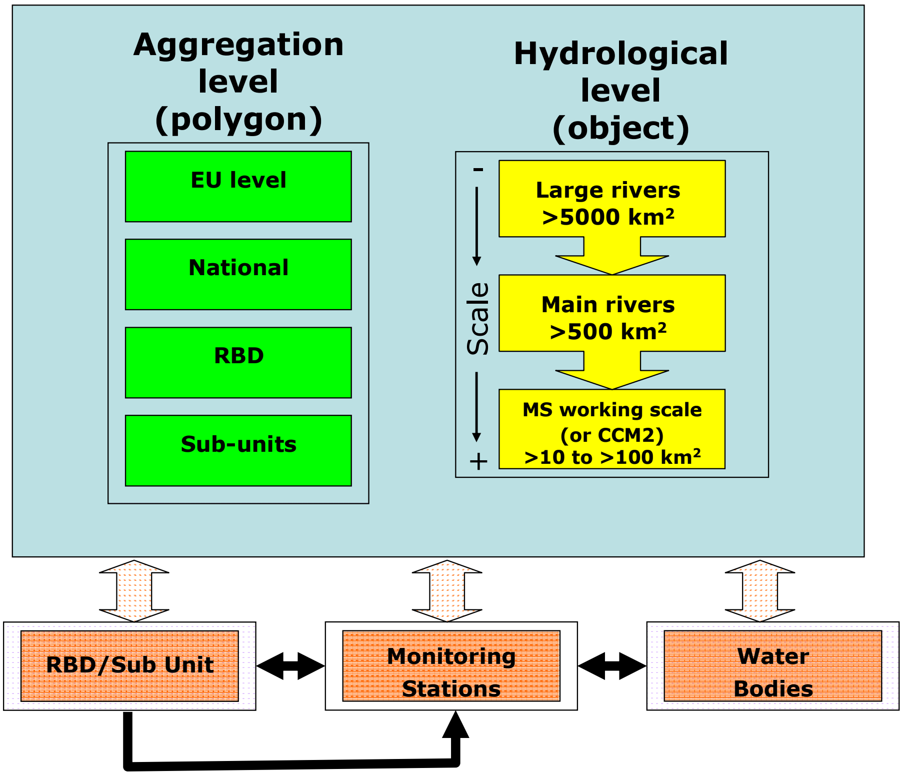


Figure 3.1.2a Visualisation of WISE Reference GIS datasets at different scales

- ***Reporting:*** future reporting exercises should be linked with the WISE Reference GIS datasets. Integrity and consistency of codes should be maintained. For example, whenever a Member State reports a river monitoring station, it should be located on and linked by code with its associated river water body (for more detailed information see Chapter 5.4).

3.2 Policy implementation visualisation

The implementation of European legislation is often divided into phases where Member States gradually implement the approaches and obligations specified in the directives. The phases cover a time span of several years. The European Commission, as a guardian of the EU legislation, is obliged to monitor the progress of implementation of the EU water legislation and to inform the European Parliament and the European Council, national governmental institutions, all interested groups and stakeholders as well as European citizens on the progress made by the Member States. The EC also informs the European Water Directors as part of the Common Implementation Strategy. The monitoring of progress, and the review and compliance checking of information related to it, has several key objectives:

- To have a general overview at the EU level on the status of the implementation of the EU water legislation;
- To identify early and resolve general problems related to the Member States' ability to implement the directive in question;

- To stress the importance of all Member States fulfilling the requirements of the European environmental legislation;
- To assess policy effectiveness.

The focus of the information on the progress of water policy implementation in the EU will, by its nature, be an overview based on simple high level indicators and map representations of key aspects of implementing water directives at the EU level, for example:

- Transposition of directives into national legislation;
- Implementation of key features of a particular legislation (e.g. establishment of River Basin Districts and identification of Competent Authorities, designation of water bodies, designation of sensitive areas and Nitrate Vulnerable Zones, establishment of a Register of Protected areas, etc);
- Establishment of monitoring programmes;
- Establishment of programmes of measure;
- Reporting to the Commission.

It should be underlined that for some water directives the requirements to show the status or progress of the implementation of a directive are rather straight forward, simply presenting and visualising the raw data reported by Member States.

Some of these data, e.g. bathing water quality monitoring sites and the status of bathing water quality, can be directly (after certain QA/QC procedures), be presented at the EU level on interactive maps using the WISE map viewer. For example, Figures 3.2.1a and 3.2.1b represent the status of implementation of the bathing water directive showing bathing water quality of inland and coastal waters at the EU as well as the MS level.

For other reported information, some aggregation, selection or clustering of reported data should be done and compliance or performance indicators derived. Visualisation of the status and performance of the implementation of a directive can be achieved using the WISE map viewer or they may be static presentations available for download (e.g. from the EEA's Atlas). Examples of such maps of indicators are:

- Overview map of WFD River Basin Districts (see Figure 3.2.1c and 3.2.1d);
- Density of monitoring stations (e.g. number of stations per 1000 km^2) visualised by Member State or River Basin District (see Figure 3.2.1e);
- Density of surveillance monitoring as reported by Member States under WFD Article 8 (see Figure 3.2.1f);
- Percentage of heavily modified water bodies visualised by River Basin District (see Figure 3.2.1g).

Development of each selected indicator and/or map will need to be clearly defined in terms of:

- The context of the directive;
- Data sources, particularly where data from different directives and/or sources are combined within an indicator;

- Derivation, presentation and visualisation.

Textual explanations of the rationale, limitations and assumptions made in the processing of the original data reported by Member State to develop indicators and present and visualise this derived information in maps will be elaborated to ensure valid interpretation.

3.2.1 Compliance assessments visualisation

In addition to the information directly requested by the EC and reported by Member States, and its visualisation using the WISE map viewer, a legal compliance assessment of the data reported against the directive requirements will be made.

The purpose of the compliance assessment is to evaluate in quantitative and qualitative terms whether a Member State has fulfilled its obligation of implementing the European legislation in accordance with the specifications and the sentiments of the legislation in question. Therefore, compliance assessment is performed by using certain methodologies and rules. The outcome or results of the compliance checking can also be visualised and presented on maps, such as displaying the status of how a Member State is implementing a certain directive.

The visualisation of the results of compliance checking can be done in two ways: by directly presenting the results of the compliance check on maps, or by developing certain indicators derived or based on the results of the compliance check.

In some cases, the outputs (maps) of the results of compliance assessments can be considered information elements in the assessment process and can provide a useful means of visually communicating the outcome of the assessments. The maps of indicators presenting results of compliance checking are used to inform EU services, European politicians, national governments of Member States and the public about the level of compliance of implementation of the water related policies.

The focus on visualising information reported on the status of implementation and compliance of directives will be as European overviews and individual country representations (using maps) with the use of derived and detailed indicators of key aspects and issues associated with implementing water directives. Examples of such compliance indicators are:

- Numbers of identified and designated water bodies in relation to the size of Member States and River Basin Districts;
- Identification of significant pressures, numbers/areas/proportion of affected waters and water bodies at risk;
- Numbers and types of monitoring sites in relation to the size of Member States and River Basin Districts;
- Numbers and types of parameters and quality elements used in monitoring;
- Frequency of monitoring;
- Level of urban waste water treatment against required designated sensitive areas and requirements for treatment based on the sensitivity of these areas;
- Bathing water quality status per bathing water against water quality requirements/thresholds for certain parameters.

It should be noted that in the compliance assessment process the EC is not limited to the information directly reported by the Member States but may apply information as deemed relevant.

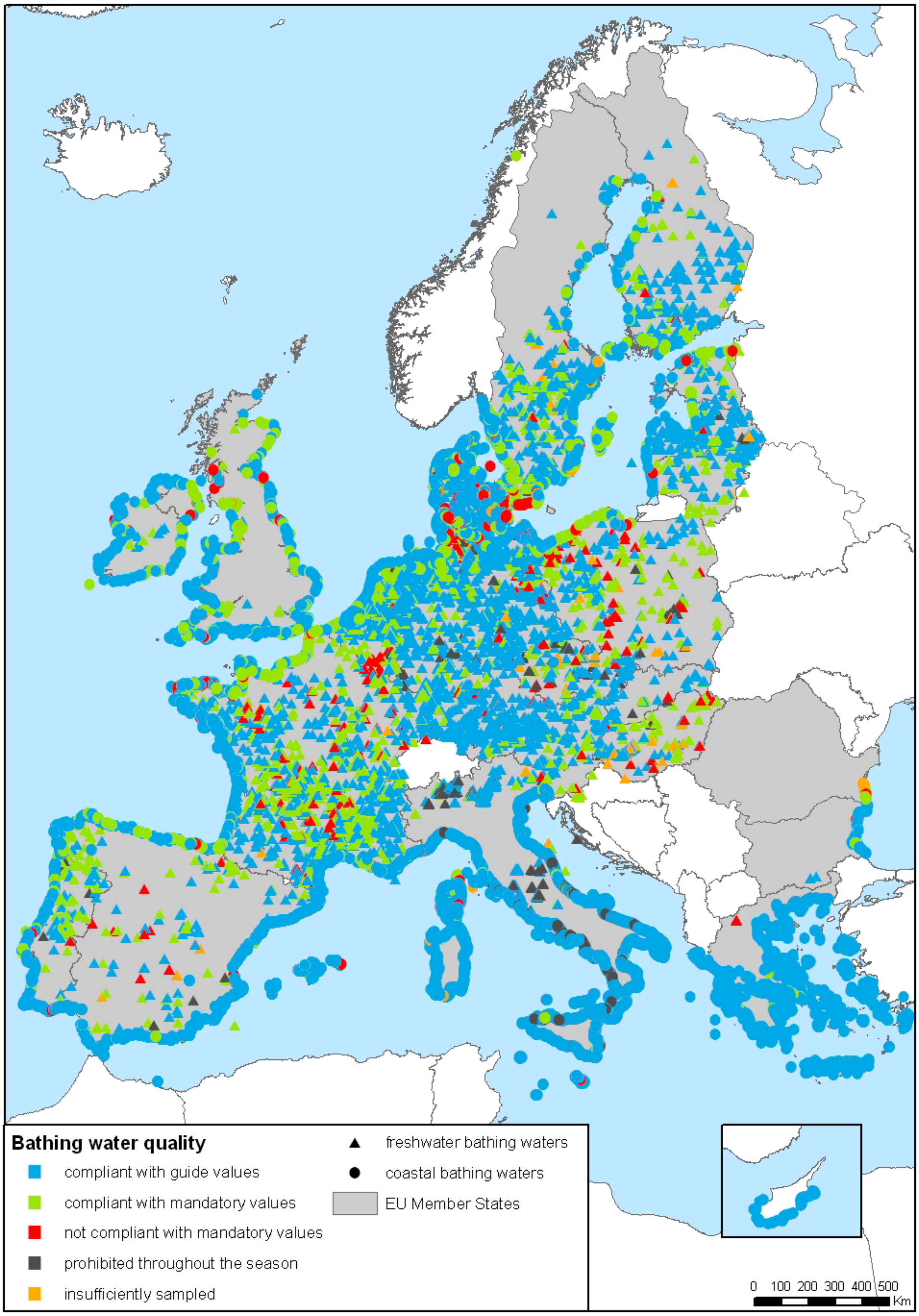


Figure 3.2.1a Bathing water monitoring stations with quality classification as reported by Member States

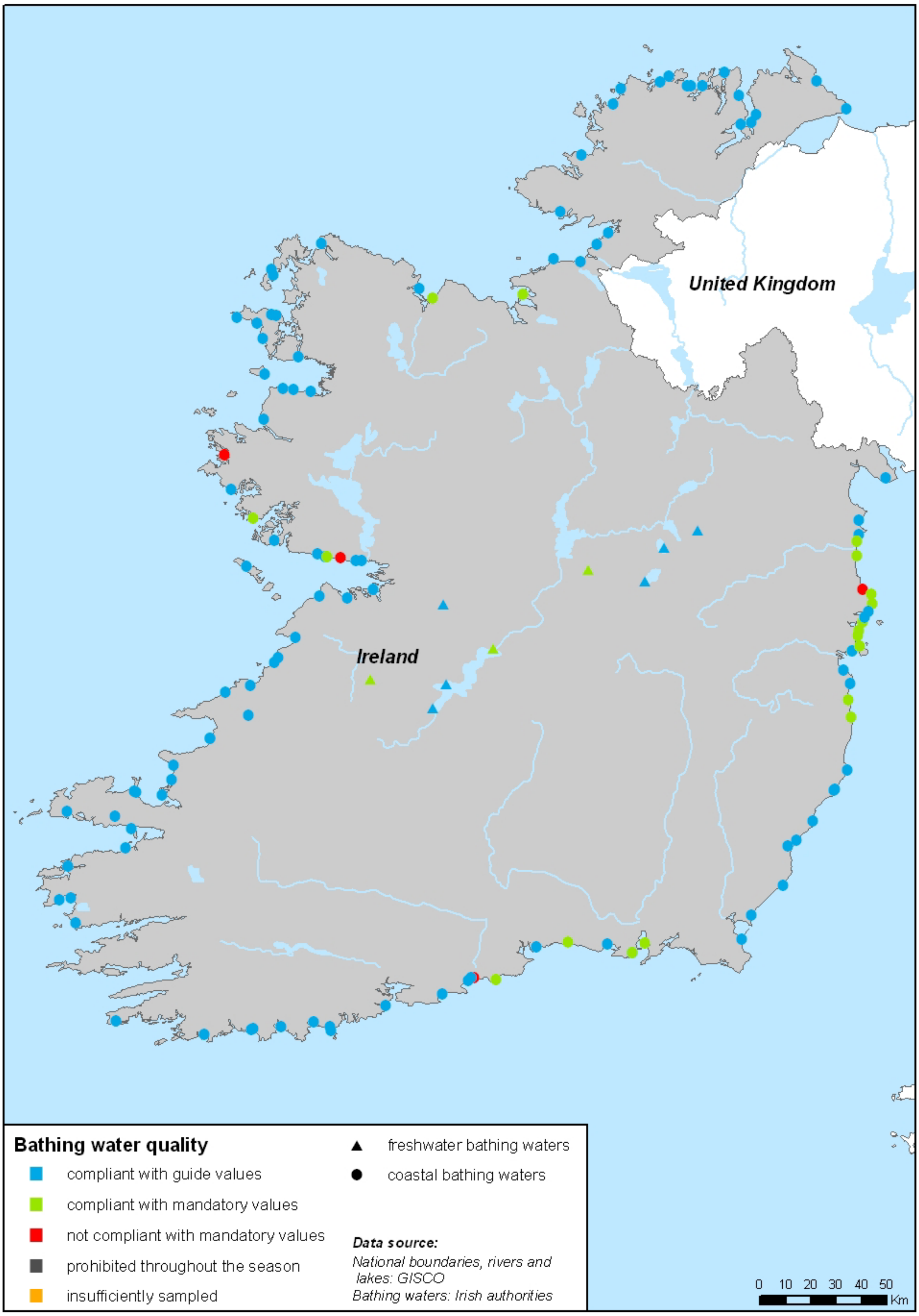
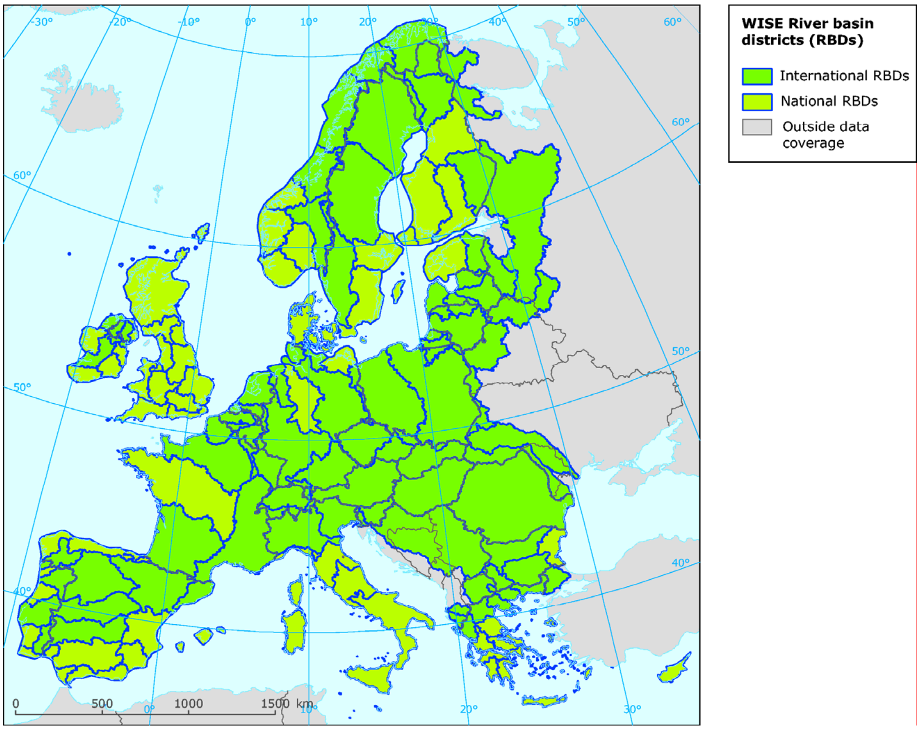
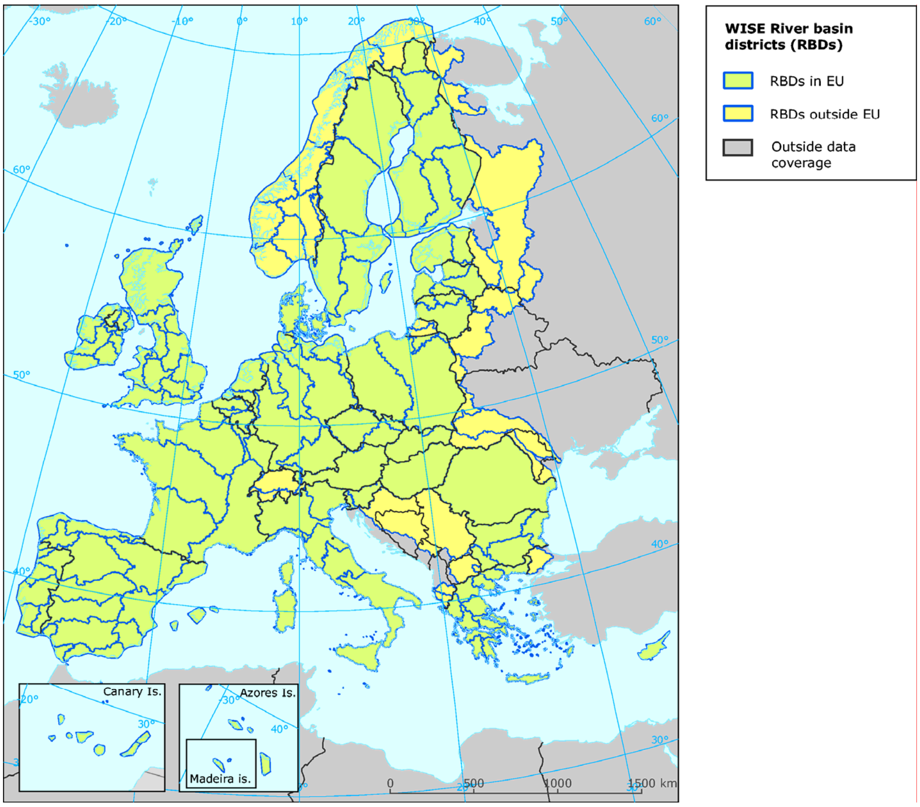


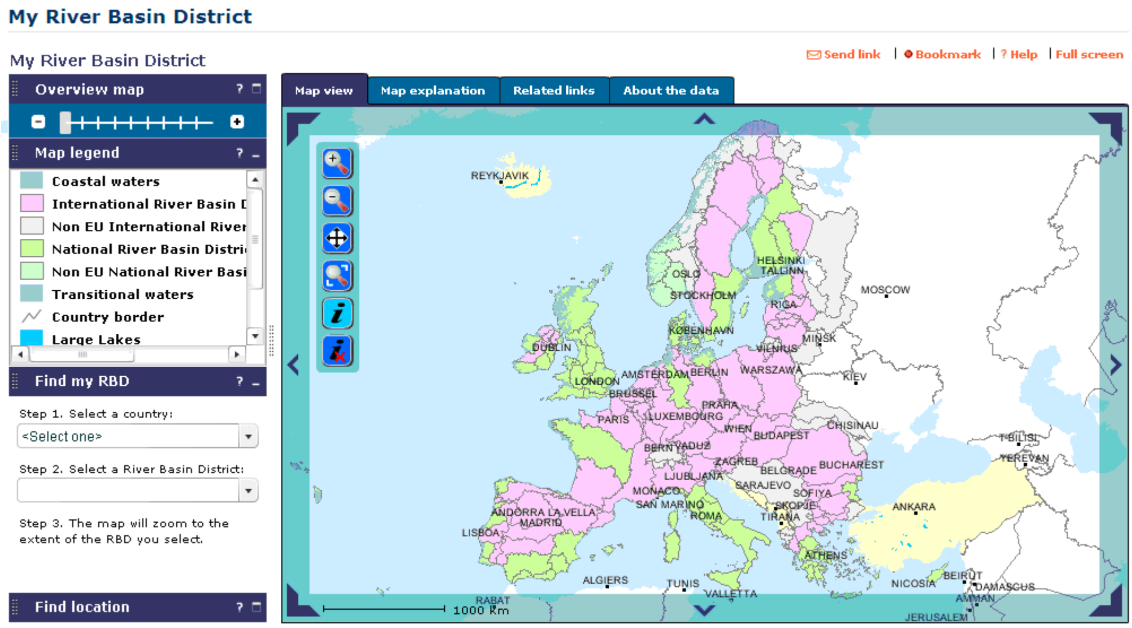
Figure 3.2.1b Detailed view into BWD stations reported by Ireland





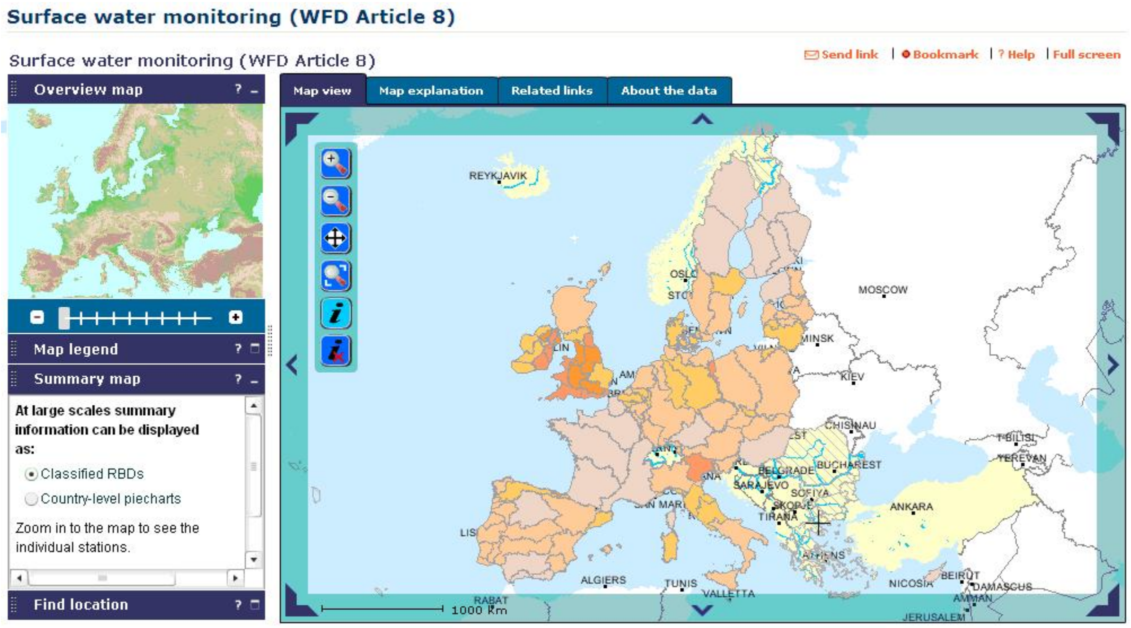
Source: http://dataservice.eea.europa.eu/atlas/viewdata/viewpub.asp?id=3687

Figure 3.2.1c Map of River Basin Districts available for download



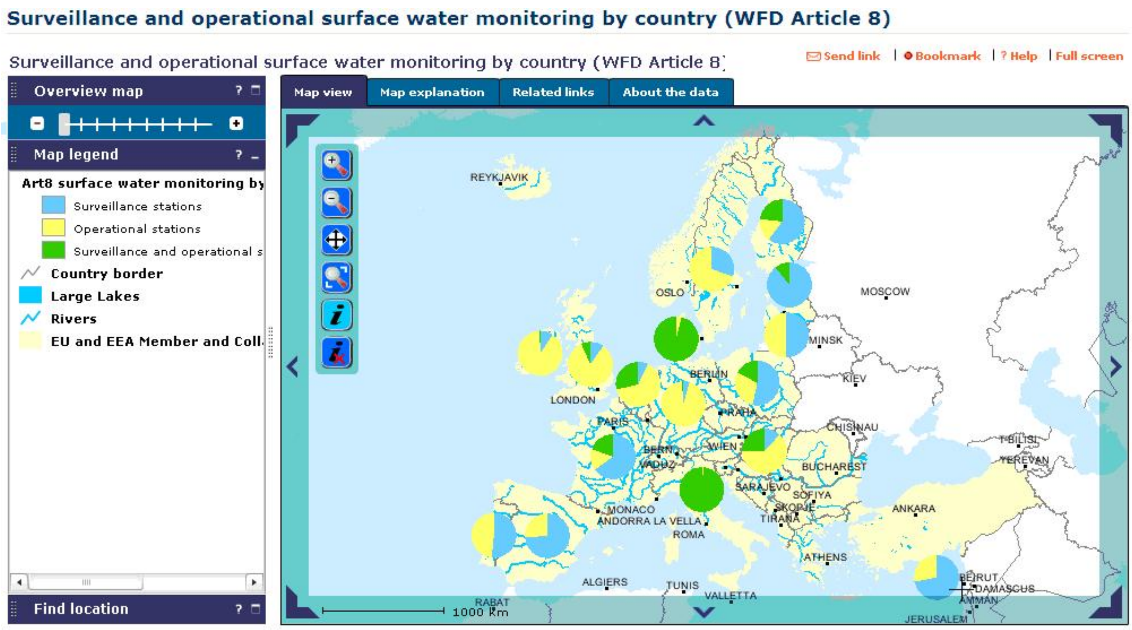
Source: http://www.eea.europa.eu/themes/water/mapviewers/myRBD

Figure 3.2.1d Interactive map of River Basin Districts



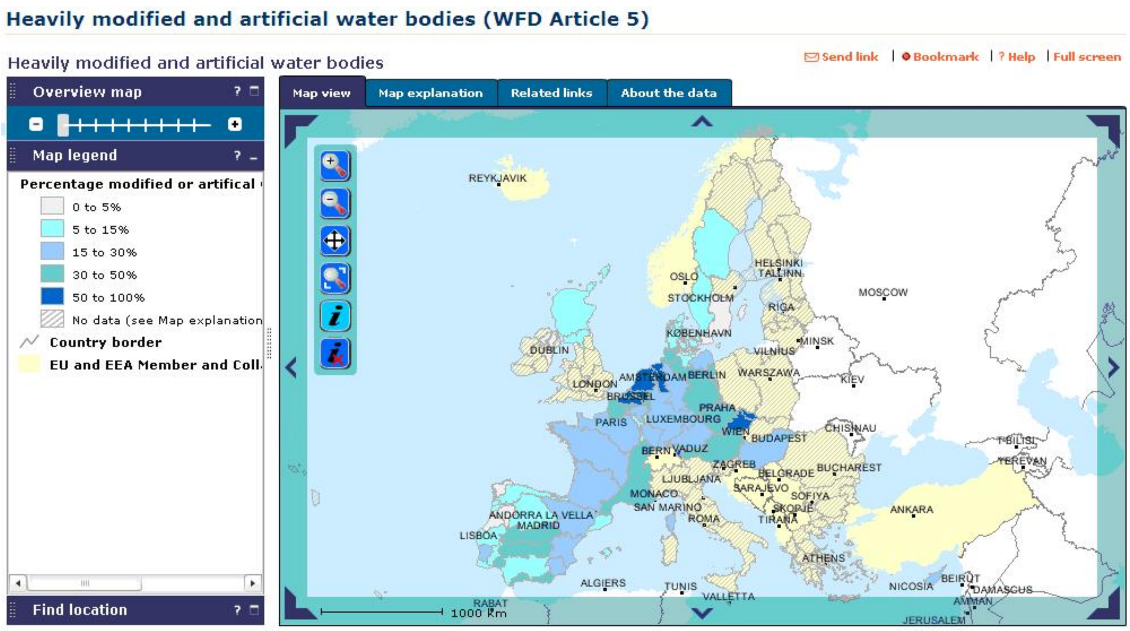
Source: http://www.eea.europa.eu/themes/water/mapviewers/art8-sw

Figure 3.2.1e Interactive map of Surface water monitoring (WFD Article 8)



Source: http://www.eea.europa.eu/themes/water/mapviewers/art8-sw-sur

Figure 3.2.1f Interactive map of Surveillance and operational surface water monitoring by country (WFD Article 8)



Source: http://www.eea.europa.eu/themes/water/mapviewers/art5-hmwb

Figure 3.2.1g Interactive map of Heavily modified and artificial water bodies (WFD Article 5)

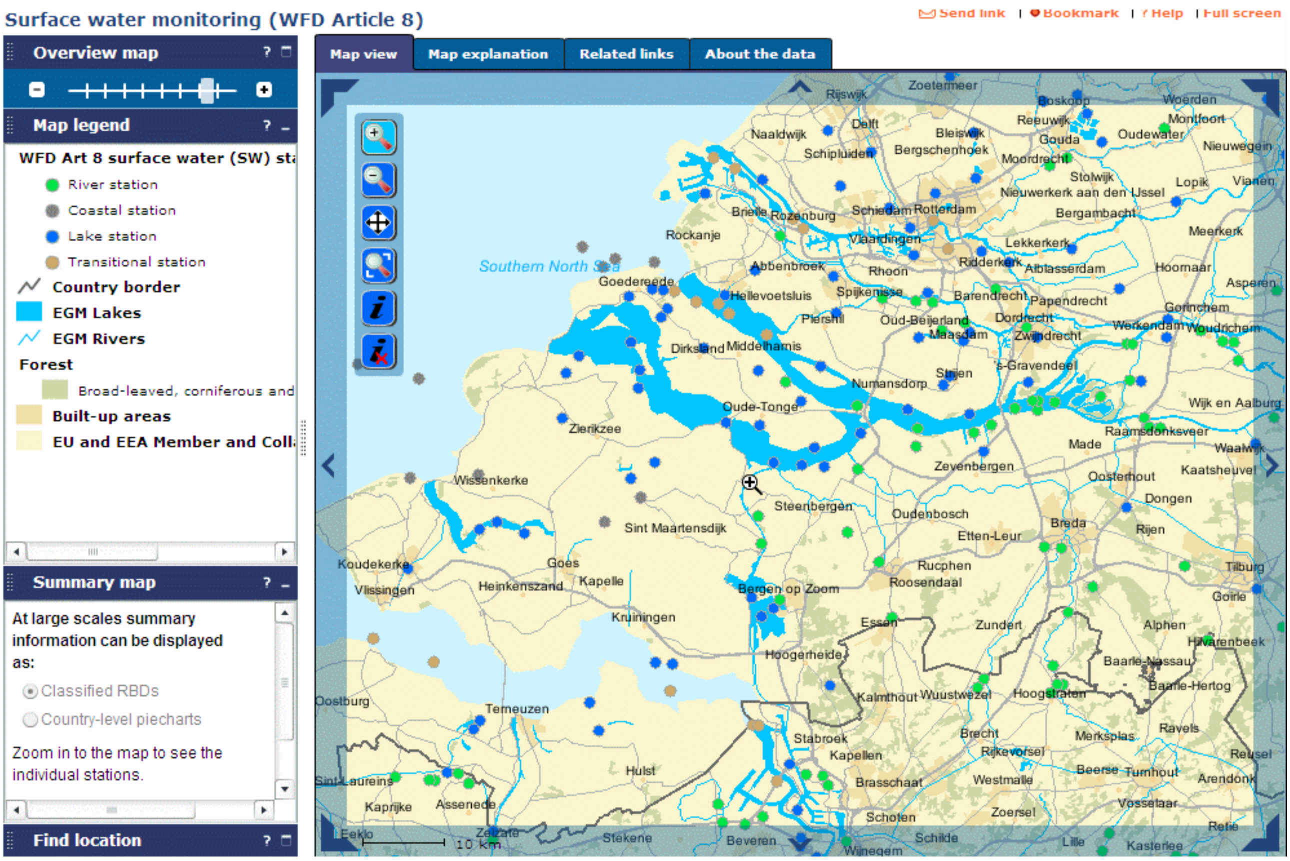
3.3 Overview of WISE map viewer application

3.3.1 Purpose and concept of the WISE map viewer

The WISE system building started in summer 2006 after a user requirement study was undertaken and an architecture document was consequently developed. From the user requirement study and from the political commitment to make data and information from the Water Framework Directive available to the general public, the development of a map viewer became a key priority.

The WISE map viewer allows the user to explore and query data presented on maps, an example of which is shown below in Figure 3.3.1.

The WISE map viewer is hosted by the European Environment Agency (EEA), in its role as water data centre. It has been developed by the EEA in consultation with the European Commission and other institutions, in accordance with specified user requirements. The WISE map viewer and a list of the interactive thematic maps that are currently available can be found at the following location: http://www.eea.europa.eu/themes/water/mapviewers/.



Source: http://www.eea.europa.eu/themes/water/mapviewers/art8-sw

Figure 3.3.1 WISE map viewer

The concept of the WISE map viewer is to package pre-defined maps and queries within a web-based interactive interface. The default view of each map is at European level, typically showing data aggregated to either Member State or River Basin

District. The pre-defined maps and queries present the information submitted by Member States as a single merged dataset at European level.

As the user zooms in the classified features (e.g. monitoring stations) are shown and the user can click on them to retrieve further information. Information is output either through a map pop-up or a table in a separate tab. Context for the map is provided in a 'Map explanation' tab, giving a short textual explanation of the definition and background to the map, and a 'Related links' tab. It is possible to search different features on the map through a search box on different layers.

Additionally, experts in each theme (e.g. relating to the Water Framework, Urban Wastewater Treatment or Bathing Water Directives, WISE-SoE, etc) have specified how data can be aggregated to either the Member State or River Basin District levels, adding value to this comparable European view. These experts are also responsible for ensuring the data displayed in the WISE map viewer has been through a quality checking procedure.

3.3.2 Technical Architecture of the WISE map viewer

After a review of the available technology options and bridging between security requirements, usability concerns and performance aspects, the WISE map viewer has been developed by the EEA for the integration and display of water related European datasets.

The WISE map viewer interface is intended to provide a rich application experience for the user when exploring the maps and data. The WISE map viewer is also designed to present the information in a readily accessible manner, hence the building of separate viewers around each map. The technology is also utilised across other of the EEA's map-based interfaces.

The data behind the client interface is currently stored in a database spatially enabled with ESRI ArcSDE technology and delivered via an ESRI ArcIMS web map service to bring the selected data to the client.

The detailed internal functionality of the WISE map viewer falls outside of the scope of this document but the viewer should be seen as a black box which controls the interaction with the user and the response and request cycle to the data services.

3.3.3 Specification of a map and its cartography

Maps displayed in the viewer have been subject to consultation, their presentation format agreed and they conform to the needs of the user. They are first prototyped by the thematic experts in a standalone ArcMap document with the available data and the user interaction described with use cases. The technical specification for each map is then documented and the WISE map viewer application is developed and tested according to the specification. The following is a list of the typical information to be included in the technical specification:

- Data preparation – aggregation and other pre-processing tasks for data display;
- Define the display – background layers, reference and other GIS datasets to be used;
- Display scale specifications – what should be shown at different zoom levels;

- Data attribute explanation;
- Visualisation of map and legend at different scales – RBG values for legend and text for legend. Value thresholds for WISE data;
- Map interaction description – pre-conditions, triggers, post-conditions e.g. output to pop-up, table or graph;
- Map explanation text and related links.

Classification of points and colouring are important elements in helping the user quickly understand what they are looking at. Within WISE, many of the datasets have precedents set on their display. Data relating to the Bathing Water, Urban Wastewater Treatment and Water Framework Directives are displayed according to the classification and colouring specified in their respective directive text. The background to the WISE maps is a set of layers developed at the EEA from various sources, optimised for web display.

3.3.4 Alternative and future map viewing options

With the development of WISE into a distributed system using service oriented architecture (SOA) principles, more ways of serving maps and visualising data will become available. The next steps of serving maps to other machines are explained further in Chapter 5.7.

The EEA will further develop map viewing options, in particular user-friendly ways to serve a wider group of users which are not specialised in GIS and who may not be familiar with the currently used viewing tools. Within the WISE website, the theme of bathing water serves as an example for more flexible ways of presenting data: see http://www.eea.europa.eu/themes/water/status-and-monitoring/bathing-water-data-viewer for more information. This includes the display in Google Earth™ or Microsoft Virtual Earth™ as well as the possibility to download data in KML format. This flexible line, supporting multiple tools will be supported in the future and will be based on open standards wherever possible.

3.4 State of the Environment visualisation

At the core of any water related State of Environment (SoE) assessment is the need to quantify and identify the current state of, and impacts on, the water environment - how these are changing in time and whether the measures taken at different levels are effective.

Such an assessment should:

- Provide the basis for identification and assessment of environmental problems and the dominant threats at regional and European levels;
- Provide information necessary to enable actions/policies to be taken to improve the environmental state of the water bodies and to ensure sustainable development;
- Be based at the most relevant time and spatial scales to meet the two objectives stated above.

The European information needed in relation to water quantity can generally be described as:

- How much is there (runoff, availability, etc)?
- What is the state of the water quality (nutrients, hazardous substances) and ecological quality?
- Is the situation getting better or worse?
- What are the pressures on the environment (abstraction and water use by sectors)?
- Are there targets in place, such as are water-pricing policies used to provide adequate incentives for users to use water resources efficiently?

The EEA bases its water quality data on a representative sub-sample of national monitoring results, which EEA member countries report voluntarily each year to the EEA. The EEA has mainly collected annual values (e.g. average, median, minimum and maximum).

In the context of the implementation of the Water Framework Directive (WFD), the EEA's Eionet-Water annual data flow for waters is in the process of being transferred into the WISE-SoE (State of the Environment) voluntary data flow. The transition from Eionet-Water to WISE-SoE reporting has already been done for water quality related determinands for rivers, lakes and groundwater. In developing this transition, there was a clear principle that there should be no double reporting. The aim is a delivery of one dataset that might be useful for both WFD compliance by the European Commission services and EEA SoE assessments.

Data from WISE-SoE reporting are stored in Waterbase (a series of SoE databases within WISE) found at:
http://dataservice.eea.europa.eu/dataservice/available2.asp?type=findkeyword&theme=waterbase.

At the end of 2007, Waterbase contained water quality information on:

- More than 6000 river stations in 35 countries;
- More than 2200 lake stations;
- Quality data from around 1100 groundwater bodies.

In the future the monitoring stations reported to the EEA will be similar to, or a sub-set of, the monitoring stations reported by countries under Article 8 of the WFD.

The data stored in Waterbase are visualised and communicated to the public using the WISE map viewer at http://www.eea.europa.eu/themes/water/mapviewers/ (see Chapter 3.3 for more information) and in the future will be supplemented by tabular data extraction templates. The freshwater water quality Waterbase databases consist of three main tables. For rivers, for example, the number of records stored in the database are:

- Waterbase-Rivers: **Stations** (6369 records);
- Waterbase-Rivers: **Pressures** (2876 records);
- Waterbase-Rivers: **Quality** (637344 records).

In addition, there is a fourth table containing **hazardous substances** (>300,000 records, not publicly available).

In 2008, the EEA and its European Topic Centre on Water began test data collections of data on water availability and water abstraction, and emissions to water. During 2009, these data collections will be established as annual WISE-SoE water quantity and emissions reporting. Work is also underway to develop data flows on biological and hydromorphological indicators.

In addition, the EEA bases its SoE reporting and indicators on data collected through the reporting of the Urban Wastewater Treatment, Nitrates, and Bathing Water Directives, as well as Eurostat's collection of data via the OECD/Eurostat questionnaire on environmental data on water availability, water abstraction, water use and wastewater treatment.

The data stored in the different databases form the basis of the EEA's water indicators. The EEA has the following core set of indicators relating to water:

- Use of freshwater resources (CSI 018);
- Oxygen consuming substances in rivers (CSI 019);
- Nutrients in freshwater (CSI 020);
- Nutrients in transitional, coastal and marine waters (CSI 021);
- Bathing water quality (CSI 022);
- Chlorophyll in transitional, coastal and marine waters (CSI 023);
- Urban waste water treatment (CSI 024).

In the near future the data behind the EEA indicators will be available via WISE.

3.4.1 Visualisation of State of the Environment (SoE) data in WISE

Data stored in Waterbase (on water quality) and collected via Member States reporting (Bathing Water, Urban Wastewater Treatment and Nitrates Directives) are visualised in the WISE map viewer.

During the visualisation process, different formats are used depending on the scale of the map:

- Often, for the scale 1:5,000,000 and less detailed (European overview), data are aggregated by country or national River Basin District (RBD) level;
  - For countries: pie charts of percentage of the variable (e.g. BOD, Bathing water quality or wastewater treatment type) classification by country is displayed;
  - The national RBDs are coloured according to the average of all the stations located within the RBD, falling within defined classes.
- For the scale more detailed than 1:5,000,000, individual station points are visible instead of a classified cartogram, and these are coloured according to the variable classification. Symbol size depends on the map scale (the more detailed the map, the bigger the symbol).

An updated list of SoE maps available via the WISE map viewer can be found at the following location: http://www.eea.europa.eu/themes/water/mapviewers.

In the future, additional maps will be added, which may include:

- Maps on diffuse nutrient pollution;
- Maps illustrating groundwater water quality;
- Water availability per River Basin District;
- Water abstraction by main sectors per River Basin District;
- Water exploitation index (available water resource divided by water abstraction) per River Basin District.

4 Principles of WISE compatibility and interoperability

4.1 What is WISE compatible?

As described in Chapter 1.2 WISE may, depending on the context, be seen as an initiative, a concept, a process, an information system, a set of rules or tools for reporting, a dataset or component or something else.

If WISE is referred to as an information system, it includes all possible WISE nodes, data and viewer providers as well as the common WISE public web site and their interactions. It is not a central "mega-database" but rather a decentralised system at EU level which will have capabilities to interoperate with existing national systems.

It is intended that WISE will cover all water-related information arising from EU water policy (e.g. Water Framework, Urban Waste Water Treatment, Nitrates, Bathing Waters, Drinking Water and Floods Directives) as well as the upcoming Marine Strategy Directive. In addition, WISE will include other water-related datasets such as Eionet-Water (now known as WISE-SoE) developed by EEA and those arising from relevant water research projects.

Because of the extent of themes and the number of stakeholders involved in developing WISE, guiding principles are required to be followed during development and implementation. The guiding principles for WISE compatibility are elaborated in the following text.

4.1.1 Standards applicable to WISE

WISE is a system merging spatial and non-spatial data from various physical locations. In this respect, an important aspect is the hosting of geo-referenced data, making WISE a building block for INSPIRE. WISE will build on the service-oriented architecture, applying the appropriate standards and specifications from the Open Geospatial Consortium (OGC), the International Standards Organisation (ISO) and the European Committee for Standardisation (CEN). The application of standards does on one hand ensure that the process takes on board experiences gained from other information management communities, and on the other hand that specifications are written so that they may be implemented by different developers and data managers independently of a specific technical solution or software.

- The OGC has developed a family of technical documents - OpenGIS® Specifications[20]. These specifications cover a wide range of aspects from the specification of how to encode spatial data for exchange to specification for various web-services needed for discovering, accessing and visualising spatial data. The OpenGIS® specifications build on other standards such as the family of XML standards. The application of the OpenGIS® standards is described in detail in Chapters 5.6 and 5.7;
- ISO has developed the ISO 19100 family of standards for geographic information (e.g. ISO 19115/119 covers metadata and services) and the specific adaptation of this is described in further detail in Chapter 5.5. CEN

[20] The OGC specifications and best practices may be found at http://www.opengeospatial.org/standards

have adopted a number of standards. An overview of the appropriate standards and status can be found in Appendix 04;

- INSPIRE – The ongoing INSPIRE process will lead to a binding set of implementation rules as well as a set of guiding documents specifying good practice. This document, "The WISE GIS guidance", follows the INSPIRE recommendations to the level available, and may thus be described as INSPIRE compliant given the constraint that reporting requirements have already been specified for a number of water-related directives. An overview of the INSPIRE technical architecture is shown in Figure 4.1.1.

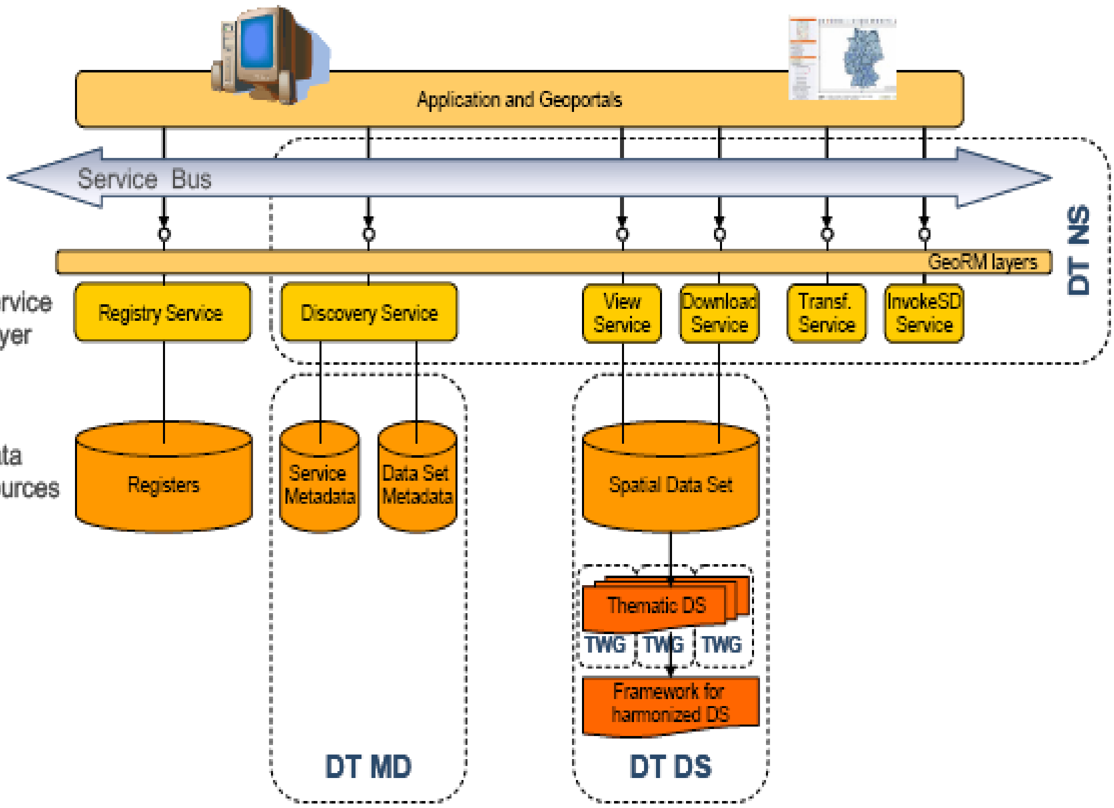


Figure 4.1.1 INSPIRE Technical Architecture overview

4.1.2 WISE compatibility

During the first 7 years of WFD implementation, a set of processes agreed by all stakeholders has been developed. WISE compatibility can be considered true when information regarding the environment is defined, gathered, exploited and disseminated as requested by the Commission. The processes follow a set of guiding principles for streamlining of reporting and the shared information system.

Streamlining reporting:

- Key principle: "Report once use many times[21] – harmonise reporting tools". This key principle overarches many of the efforts in streamlining the reporting processes between stakeholders at all levels;
- WISE will integrate State of the Environment (SoE) and compliance reporting data flows and, where appropriate, others. The principle here is a natural outcome of the key principle, as it will reduce the burden of reporting for mandatory and voluntary data flows;
- Follow the Subsidiarity Principle;
- Data should be maintained at the most appropriate level and shared between all other levels;
- To be WISE compatible means applying the collaborative processes developed as part of the WFD Common Implementation Strategy. Part of the process is to identify the most appropriate type and level of information either to be available or to be reported at the European level. Other parts of the collaborative process ensure both the sharing of good practise and common ownership of the policy implementation (see Chapter 1.2);
- Use of MS data for visualisation and analytical purposes according to the “WISE reporting arrangements”. The unrestricted use of MS data is a paramount requirement for the multiple uses of the data. MS data may be aggregated and compiled into seamless European wide layers (see Chapter 6);
- Reporting based on public schemas and multi-approach tools. The reporting is based on XML schemas which are independent of vendor specific software. MS are, to a variable degree, capable of preparing XML documents from their information systems. Tools have thus been developed to organise, validate and reformat data according to the reporting schemas. The reporting schemas themselves fit into the service-oriented architecture;
- Data processing follows an open and agreed process. The procedures for accepting, validating and exploiting the data reported by MS to WISE follow a standard procedure as illustrated in Figure 4.1.2a.

It is important to note that recommendations and specifications in this guidance build on the existing processes (reporting methods, schemas, Reporting Sheets etc). The future developments may require changes of a technical nature (reformatting of specifications etc), but the actual content will continue and be stable over time.

[21] Data should be collected once, maintained at most appropriate level and shared between all levels.

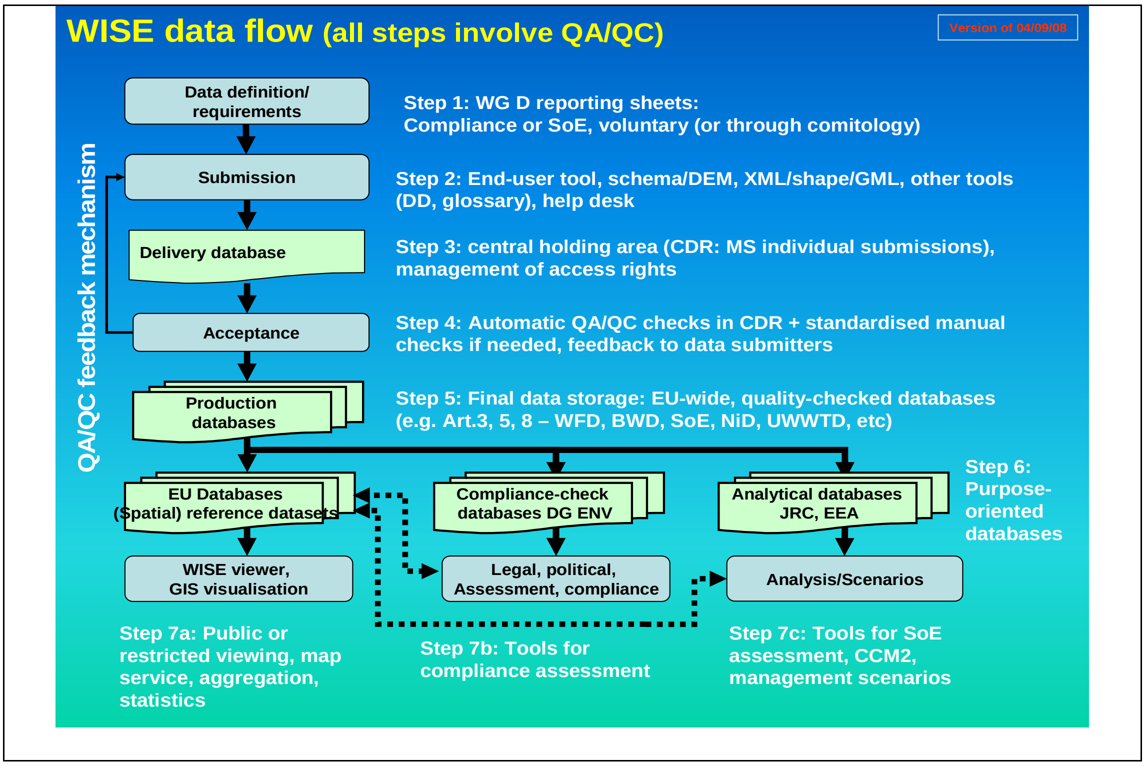


Figure 4.1.2a WISE data processing flow

Shared Information System:

- WISE is built as distributed data nodes (see Figure 4.1.2b). Data should be stored at different nodes and information should be shared between all participating nodes. It is not the intention that a data node will contain the full dataset. The distributed nodes are an application of the Subsidiarity Principle;
- Vertical integration between local, national and European levels. Vertical integration is supported by specifying spatial objects which, through stable identifiers, can serve as links to more detailed information at national / local level. These stable identifiers ease reporting provided that the spatial data is stable over time. However, an effort to maintain vertical integration is required to keep temporal track of the spatial changes;
- Interoperable system;
- For the sake of information sharing and exchange, all participating nodes must be interoperable. Data should be exchangeable and services should be able to access and process data from different nodes;
- Transparent system (open);
- It should be easy to discover data and services. Users should be able to determine fitness for purpose of data and the conditions of usage should be clearly described.

Ultimately, WISE should centralise only those data which are needed as a reference against which reporting is made. The major part of information and data will be decentralised which means that linkages between national water information systems and WISE will need to be established.

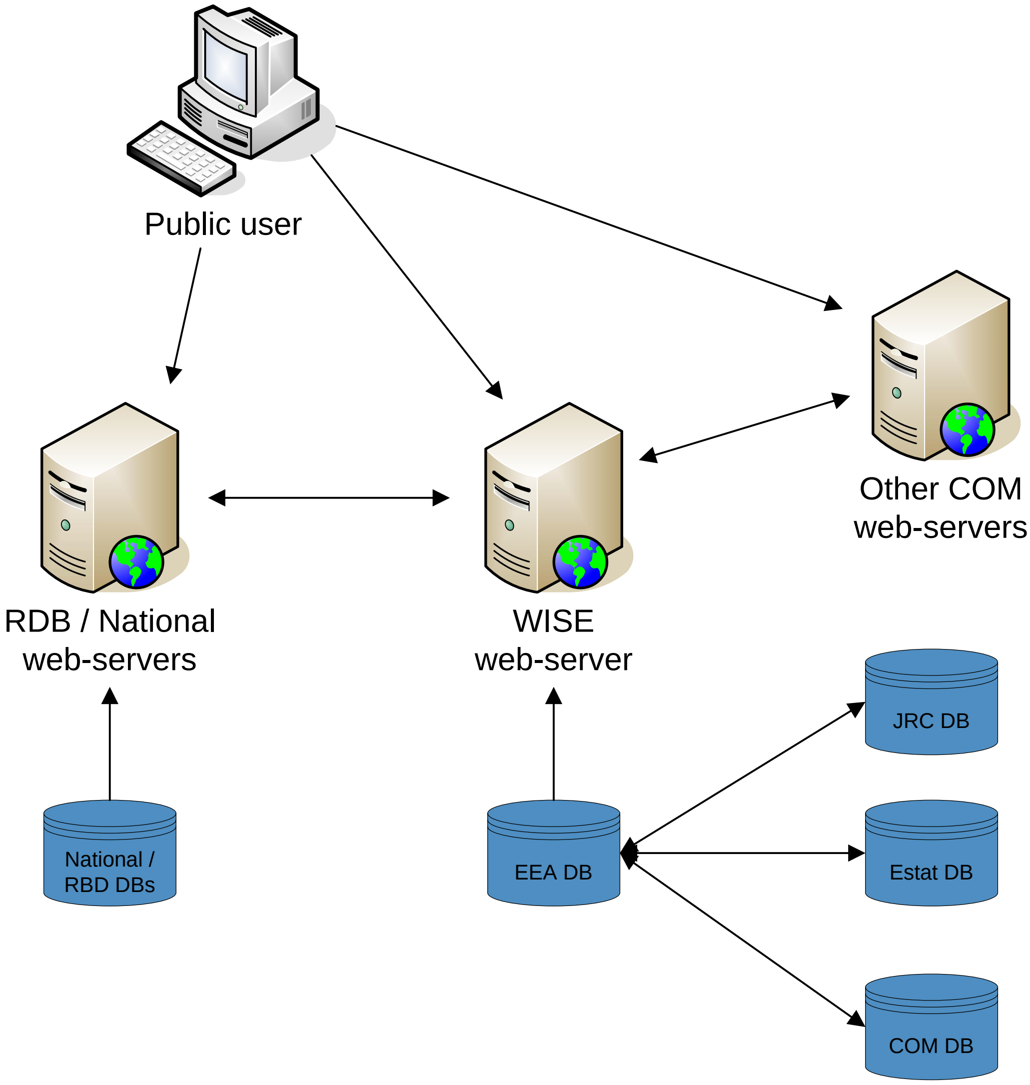


Figure 4.1.2b WISE network of databases and web-servers

4.1.3 WISE interoperability

Interoperability "is the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units" (CEN Technical Report 15449[22]).

Interoperability between systems and components has other aspects:

- Network-protocol interoperability allows communication between components;

[22] CEN/TR 15449 "Geographic information – Standards, specifications, technical reports and guidelines, required to implement Spatial Data Infrastructure" CEN/TC 287.

- Standard interface specifications can enable clients to perform procedures on a remote system;
- Data transfer interoperability allows access to data, sharing of geographic databases and other services independent of the proprietary format;
- Semantic interoperability concerns the ability of an application to interpret data consistent for common representation or processing.

WISE interoperability will, in the short term, focus on the level of “data transfer interoperability” which will be based on a agreed set of public and open specifications for web services. The web services will be responding to requests that are encoded using WISE semantics and will return a WISE related dataset.

The long term recommendation for WISE interoperability aims at semantic interoperability. This level of interoperability is however not sufficiently mature neither at the technical level (tools for semantic processing) nor at the level of adequate thesauri and ontologies or the adaptation in Member States. The semantic interoperability will open for a use of the wider set of voluntary data services related to the water domain based on local requirements and priorities and disseminated by national and regional institutions. The services are already in place in several Member States but are not currently well adapted for international use.

WISE as a shared and interoperable system is reinforced by a number of decisions:

- WISE is based on open and service-oriented architecture;
- WISE web map nodes will serve the community with small scale data, whereas national and regional data nodes are expected to provide data services at a larger scale;
- Users can build own services to connect their data to WISE or access WISE data.

The service-oriented architecture implies that all the harmonisation described is performed at the “service layer” level. Any of the data sources will have full freedom to model and organise their data in their databases according to their own needs as long as the provided services correspond to the WISE data models and common agreed service specification. See Figure 4.1.2b for the INSPIRE service-oriented architecture model.

The European WISE portal serves the user community with pan-European spatial views at smaller scales. When zoom levels go beyond 1:250,000 the data sources should be from national web servers. The distributed responsibility for providing information at different scales and the freedom for users to build own services and connect their data to WISE or access WISE data require the WISE system to contain the necessary registries for:

- Data models and specifications and service specifications;
- Other WISE nodes.

Another WISE related requirement is the interest and willingness from Member States to deliver data and services prepared for pan-European viewing.

In the WISE implementation of the service-oriented architecture, the responsibility will be shared between MS and the European Institutions (DG ENV, ESTAT, JRC and EEA) in the following way:

- EEA / DG ENV have already implemented View services at the WISE portal. It is the responsibility of the EEA to develop the necessary Registry services to support the MS with data and service specifications and to develop Discovery services allowing the WISE nodes to register their data and services and allow users to discover these.
- MS can implement View services and Download services and, in the future, will be able to register the associated metadata for data and services at the WISE Discovery service.

Chapters 5.6 and 5.7 describe further details of data exchange, interoperability and web services.

4.2 Update of existing datasets

4.2.1 Introduction

The term "update" implicitly assumes that data is reported to replace earlier reported data. The following WISE reporting arrangements have been agreed:

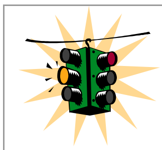
> "*Member States will be allowed to update their information and data* ***at any time****. Whilst the updating of information in between the reporting deadlines is voluntary, it will be beneficial always to ensure that the latest, correct information is available in WISE since that will be the one used for compliance checking and publication (adding a reference year to the data)"*. (WISE reporting arrangements[23]).

Updates can be limited to a single data object or as large as the full dataset. Under WISE two sorts of updating data are considered:

- **Data resubmission** is the update of a complete dataset. The resubmission is necessary when:
- Data is missing;
- Data is not provided according to the agreed structure, format or detail;
- Mismatch between reported data (e.g. water bodies provided for Article 5 WFD and included in the monitoring dataset reported under Article 8 WFD);
    - o Resubmissions are always initiated by the European Commission (DG Environment).
- **Data update** is the submission of modified data compared to a previous submission. Updates can be either descriptive updates, geometry updates or both. A Member State can update its data at any time which helps:

[23] Guidance on practical arrangement for electronic reporting to the Water Information System for Europe (WISE); "WISE REPORTING ARRANGEMENTS "; Final Document (01/03/2007) http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/w-wise_background/arrangements_1307doc/_EN_1.0_&a=d

- Member States to avoid intensive update exercises at specific reporting deadlines because all updates are frequently submitted to WISE;
- EC/EEA to update its reference datasets more frequently;
- EC/EEA to provide the most up to date statistics.



Look out!

Data reporting is the submission of data according to deadlines defined by different reporting exercises (i.e. defined by directives as well as voluntary-based reporting such as WISE-SoE and on water statistics by Eurostat/OECD Joint Questionnaire, etc)

According to this, update of WISE geographical and descriptive data at reporting deadlines (legal or voluntary reporting) can be considered as special cases of the arrangement "at any time".

After the first reporting date EC assumes it has the MS latest data available through regular update procedures by the next reporting date.

The procedures of the update process play an important role in the success of a reporting system. Therefore special attention has to be paid to set up a well-balanced system which includes all necessary rules to guarantee the correct use of updated data and to be able to follow developments in time. The paragraphs below will explain these procedures in more detail.

4.2.2 Technical data update flow

Due to the wide variety of data that is reported under WISE not all data can be treated the same regarding the technical update procedures. In Figure 4.2.2a, four different types of update are presented. The types are based on their update frequency and the number of objects that are reported (see also Chapter 5.7). Typical usages of each type are:

- Type I: This type could be the update of an attribute for a single object. For example when the name of a specific water body has changed;
- Type II: This type could be the update of a River Basin District. A single object is reported and it is most likely that a Member State is updating its River Basin Districts infrequently;
- Type III: This is a less common type but could be used for example to exchange aggregated datasets;
- Type IV: Some Member States may revise the complete dataset of their major rivers (new surveys). In this case the Member State reports a complete dataset on a certain topic.

	High frequency	Low frequency
Object based	Type I	Type II
Dataset based	Type III	Type IV

Figure 4.2.2a Technical update types

To organise the update procedures, all WISE data will be classified according to the technical update type, the data objects size and the need to update the data for dissemination. In the future WISE will have two methods of update flows:

- Flow 1 will use INSPIRE-like services to communicate between MS and the EC. This flow typically handles updates of descriptive data and point geometries. Flow 1 can process single data objects or lists of complete datasets;
- Flow 2 will be the reporting through Reportnet. This will allow MS to continue to use existing systems. Furthermore this flow will handle all line and polygon geometries. Flow 2 will always handle complete datasets.

Flow 1 is a new method of reporting which will require some additional explanation, as all data submitted to WISE has to undergo several processes and QA/QC procedures. In flow 1 WISE aims at near real time updates of data to be able to incorporate changes pushed by national systems and to ensure that the latest correct information is available in WISE.

Figure 4.2.2b illustrates the data flow and the QA/QC procedures after data (re)submission or update:

- On MS data submission to WISE (1) an immediate message that data are in WISE will be processed and generated (2a).
- Automatic quality checks are performed and MS will be informed when the data could not be processed correctly (2b – feedback to MS). Aspects such as formal quality, data consistency and data content checks will be taken into consideration (see also Chapter 6.1).
- The data processing will not continue until MS deliver data of sufficient quality.
- After this QA/QC feedback mechanism the data will be incorporated into WISE (3), data currently used in WISE will be updated and data will be available for several purposes and processes as mentioned above

(update/preparation of WISE reference GIS datasets (4a), compliance checks (4b), analysis, and visualisation).

- These processes will have additional QA/QC procedures and a report will go back to MS if data do not fulfil the requirements.

Data related to reporting periods (e.g. legal and voluntary reporting) or update cycles (e.g. WISE reference GIS datasets) will be tagged with the respective update or reporting period and its reference date.

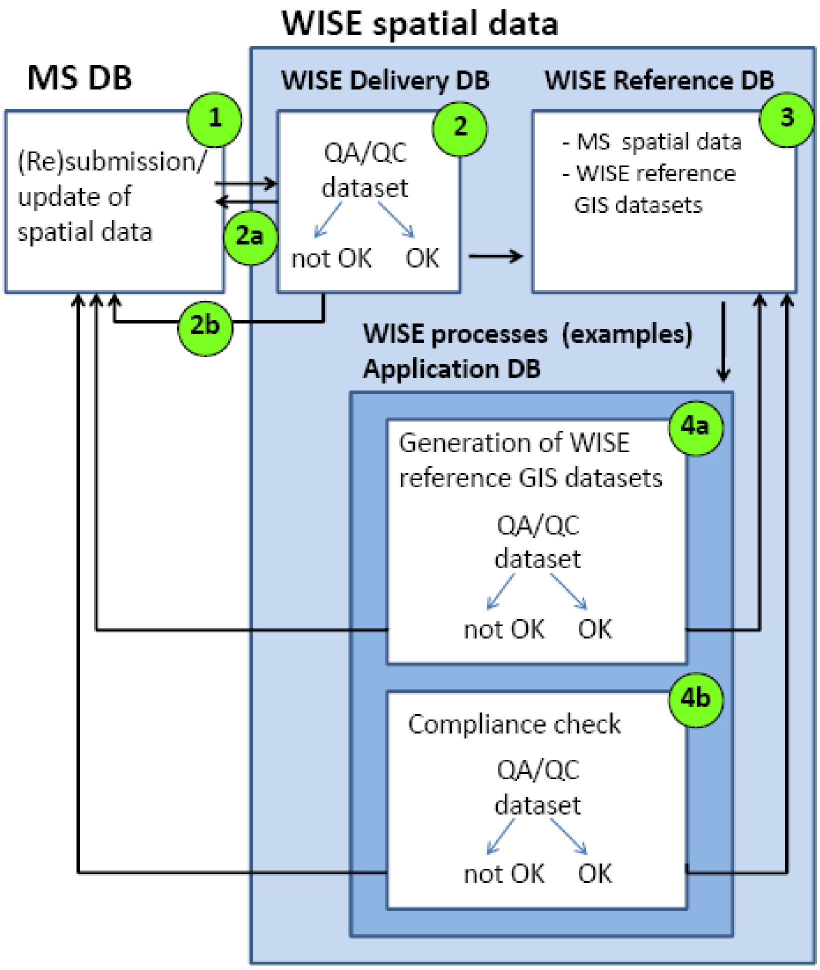


Figure 4.2.2b Submission/update of MS data: general data flow and QA/QC procedures

4.2.3 WISE update arrangements

4.2.3.1 Legal and voluntary reporting

Each water-related directive will have its own reporting deadlines. In accordance with these reporting deadlines, periods for resubmission and final deadlines will be defined. The data available at this deadline will be used for compliance checking. It will be referred to as the final dataset for the defined reporting period and tagged accordingly. Data submitted after this deadline will not be integrated into the compliance check process until the next reporting period. However, they will be available in the WISE Reference Database and can be used for the production of WISE Reference GIS datasets and integrated into the WISE map viewer.

Figure 4.2.3a illustrates possible data flows according to reporting obligations using either the possibility to update WISE GIS data at any point in time or the submission of GIS data at reporting deadlines. The update process for legal and voluntary reporting can be structured according to reporting deadlines. A submission process with a definite reporting deadline will be followed by a QA/QC period and probably resubmission of data (with a resubmission period and resubmission deadline). After this deadline, the final dataset will be included in the WISE Reference Database.

Member State GIS data already available in WISE need not be reported again. MS need only to refer to the relevant dataset, reference period and reference date. The GIS data necessary to carry out the relevant legal processes will be taken from WISE.

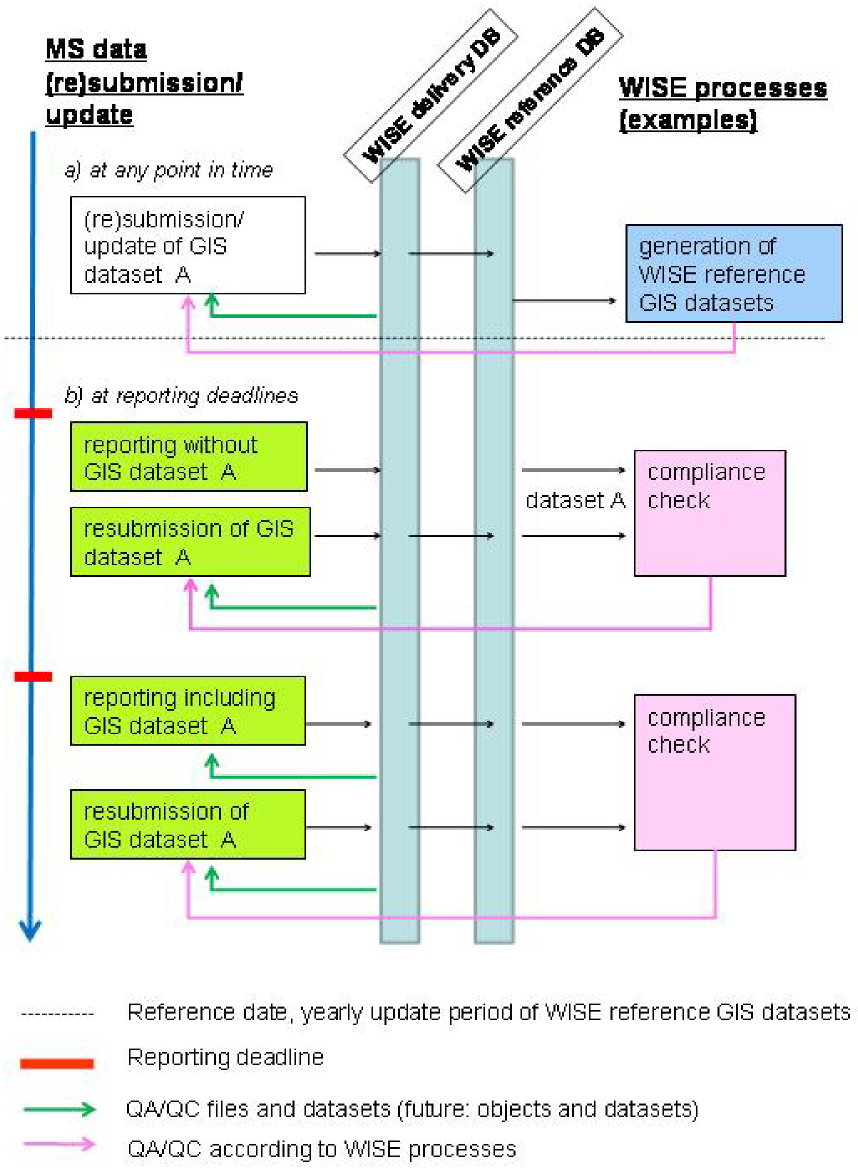


Figure 4.2.3a WISE GIS data flow and processes

4.2.3.2 Further principles:

- All submitted and resubmitted datasets will be stored in the system. The final dataset used for compliance checking will be tagged with the reference date of the reporting period;
- All datasets belonging to the reporting period have to refer to the same reference date or reference period;
- If data are submitted which are linked to already existing WISE GIS data, the proper reference to the relevant dataset has to be provided;
- Reporting cycles, the official reporting deadlines and the resubmission deadlines for each water-related directive and reporting periods within these directives will be published and made publicly available in WISE.

4.2.3.3 WISE Reference GIS datasets

As described in Chapter 3.1, there will be a set of WISE Reference GIS datasets prepared at the European level. The data source of these datasets will be:

- MS submitted GIS data:
    - Either according to the reporting obligations of the different water-related directives;
    - Or based on voluntary reporting (other GIS datasets).
- Pan-European datasets such as those from GISCO (background GIS datasets), Eurogeographics (e.g. Euro Regional Map) or JRC (CCM2). These are termed External GIS datasets.

WISE Reference GIS datasets will be **updated annually** (see Figure 4.2.3b). A near real time update will not be possible because these data will be harmonised and need an in-depth quality analysis and feedback to Member States. The update period will be closed by a defined reference date. All data submitted within the period up to the reference date will be processed. After the QA/QC period the dataset will be released and tagged with the reference date. The dataset will be available in the WISE Reference Database and the WISE web viewer.

The following principles will apply:

- The process of preparing the datasets using data provided by MS will be transparent for MS (see Chapter 6.2);
- During the time of data preparation for a WISE Reference GIS dataset and in the case of open questions, MS will be contacted to ensure the correct interpretation and use of submitted data. MS data will only be used for the compilation of WISE Reference GIS datasets if the QA/QC procedure could be finalised within a given period of time and the data are accepted and validated. All MS datasets used or not used (QA/QC not finished) for the WISE Reference GIS dataset will be marked accordingly;
- The WISE Reference GIS dataset will be released for further use by EC through the WISE portal;

- WISE Reference GIS datasets will be provided for download. They will be published with a version number and time stamp. Furthermore, detailed documentation of data sources of the respective WISE Reference GIS dataset will be available;
- WISE Reference GIS datasets will be published in the WISE viewer.

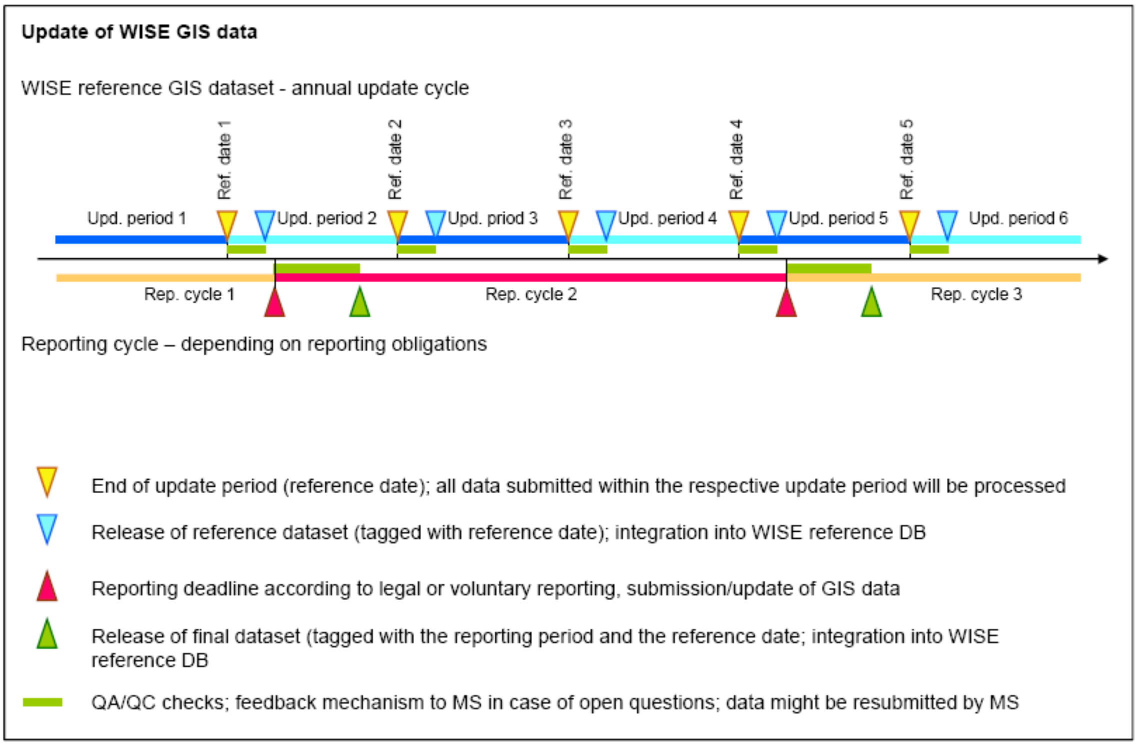


Figure 4.2.3b Update of GIS data according to the annual update cycles of WISE Reference GIS datasets or reporting cycles

4.2.4 General principles and responsibilities

The main principle of the update process should be "keep it simple". The amount of data reported under the various water-related directives is quite different. Although update of single records might be relevant it has for the time being been decided only to accept complete datasets regardless of the amount of changes.

The current decisions for WISE are:

- If data are updated/resubmitted complete datasets have to be submitted;
- All datasets related to each other will be tagged automatically at reception by EEA so that a) datasets belonging together can be easily identified and b) during an update process MS get informed which datasets are related and might need an update as well (e.g. WFD monitoring dataset includes water bodies and refer to the water body dataset);
- MS submitted data will be available in the WISE Reference Database and it will be traceable which datasets have been used for compliance checking purposes (reporting obligation, reporting period, reference date) and WISE Reference GIS datasets (update cycle reference date);

- All reporting and update cycles will be managed at EU level and published in WISE.

In future, with the realisation of the WISE distributed system architecture, update of single records or partial updates will be possible (Type I data flow).

EC and Water data centre (EEA) will be responsible:

- To set up a reporting system which allows an easy update of submitted data (and define the reporting steps and name a person responsible for each step);
- To define the reporting cycles and deadlines, the data flow and how the update has to be done in technical terms;
- To manage the reported data and update WISE Reference GIS datasets;
- To provide all relevant information and support to MS.

The **documentation of the updates** carried out for each dataset will be crucial. MS will be responsible for providing metadata describing the updated datasets (see Appendix 11 for detailed description of metadata content). EEA will be responsible for document updates of WISE Reference GIS datasets.

For various needs, in particular for QA/QC procedures carried out by WISE partners, it will be necessary to **follow changes in time and trace back information**. In several cases it might be necessary to know if all relevant features have been reported from one reporting period to the next one. This applies also for data resubmission and data update. More information about this can be found in Chapter 4.4.

Since WISE covers all water related reporting, **unique identification of spatial objects** is of fundamental importance for the reporting process. Details about identifier management are given in Chapter 4.4.

4.3 Creation of new datasets

Geo-referenced data form an important part of WISE, making WISE a building block for INSPIRE.[24] The integration of spatial information into WISE, the guidance given to Member States how to set up their water-related spatial information as regards reporting to WISE and particularly the creation of datasets for WISE should therefore be guided by INSPIRE principles.

"INSPIRE (such as WISE) *should be based on the infrastructure for spatial information that is created by the Member States and is designed to ensure that spatial data are stored, made available and maintained at the most appropriate level."*

Spatial information in WISE will be provided from several sources and will serve several purposes (see Chapter 2). The main differentiation of spatial information reported to WISE, prepared for WISE, used and visualised in WISE will be:

- Data provided by Member States (thematic data arising from reporting obligations);

[24] http://inspire.jrc.ec.europa.eu/

- Harmonised reference datasets at EU level: WISE Reference GIS datasets (see Chapter 3.1);
- Background data for visualisation (e.g. administrative boundaries, cities; to provide geographic orientation in maps);
- External GIS datasets to support further analysis and visualisation (e.g. CCM2).

The sources of spatial information and potentially new datasets are:

- Spatial information provided by Member States;
- Compilation of pan-European data from third party sources (e.g.CCM2 from JRC);
- Third party products (e.g. Eurogeographics – Euro Regional Map).

Third party products and third party sources of spatial information will not be addressed but this Chapter shall help:

- Authorities in Member States in creating water-related spatial information;
- EU bodies in compiling pan-European harmonised spatial information for WISE from Member States inputs (e.g. WISE Reference GIS datasets);
- EU bodies in planning to integrate the reporting of water-related directives into WISE.

Recommendations for the creation of new spatial information for WISE are given in Chapters 4, 5 and 6. Special attention has to be paid to the requirements given in:

- Chapters 4.4 Management of Identifiers and Codes and 5.4 European Feature Coding; set up of identifier management according to INSPIRE rules and guidance given in this document, including the specification of lifetime rules of objects and historic data management; description of object referencing between datasets and the maintenance of it;
- Chapter 5.1 General approach for the definition of datasets; development of data specification according to INSPIRE Implementing Rules;
- Chapter 5.5 Metadata;
- Chapter 6.1 Validation and harmonisation of geometry, data definitions, data models, naming.

4.3.1 GIS datasets reported by Member States

Member states will report spatial datasets to EU bodies under various articles of the WFD. These datasets come from national repositories which are not necessarily geometrically aligned across national borders or to a pan-European coastline. To connect borders of River Basin Districts or rivers across national borders, one option for Member States will be to align their data with a selection of EuroRegionalMap at scale 1:250 000. This data selection essentially comprises the national borders, the coastline and hydrological features that cut across national borders. Member States will be able to download these data sets free of charge from a dedicated section of

WISE provided they do not use these data for any other purpose. Download will be restricted to authorised persons in the water authorities.

The main concern of the Member States will be the correct use of their spatial information provided for WISE. To allow the correct:

- Use of spatial information in WISE - Member States shall provide metadata according to the WISE metadata profile (see Chapter 5.5);
- Linkage of different datasets (including non spatial data to spatial data) – Member States shall follow the principles of coding (see Chapters 4.4 and 5.4);
- Assessment of data at EU and RBD level - data should be harmonised, Member States shall follow the principles of coding and data update/resubmission (see Chapters 4.2, 4.3 and 4.4).

Furthermore, other guidelines to create and report spatial data for a specific reporting purpose have already been developed (UWWTD, NiD, BWD) and will be further developed and Member States should follow the specifications given there.

4.3.2 WISE Reference GIS datasets

The agreed WISE spatial data policy[25] allows the use of submitted data by the Commission and the EEA for deriving new geographic datasets (see Appendix 03). As described in Chapter 3.1 data provided by Member States will also be used to produce WISE Reference GIS datasets. The creation of the WISE Reference GIS datasets will follow INSPIRE principles.

In addition to the recommendations mentioned above the following specifications and descriptions for WISE Reference GIS datasets should be followed, if applicable:

- Special rules concerning the update of data (e.g. as regards ID management, development and maintenance of object referencing, historic data management, data harmonisation);
- References between the WISE Reference GIS datasets and Member State provided datasets and the maintenance of object referencing;
- Use of WISE Reference GIS datasets in WISE;
- Use of WISE Reference GIS datasets by Member States.

4.3.3 Integration of water related reporting mechanisms into WISE

The initial focus for WISE was the Water Framework Directive (WFD). However, WISE will step by step implement the data upload, sharing and analysis requirements of all water-related directives and supranational reporting. By now, in addition to the WFD, the integration of the UWWT Directive is under progress. The Bathing Water Directive will follow (see Chapter 1.2 for more detail). Guidance given to Member

[25] Guidance on practical arrangement for electronic reporting to the Water Information System for Europe (WISE); “WISE REPORTING ARRANGEMENTS ”; Final Document (01/03/2007)
http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/w-wise_background/arrangements_1307doc/_EN_1.0_&a=d

States to prepare and report the relevant spatial information should follow this WISE GIS guidance. To cover all necessary aspects a template of a short GIS guidance for specific reporting has been developed (see Appendix 13).

4.4 Management of identifiers and codes

4.4.1 Introduction

Since WISE covers all water related reporting, unique identification of spatial objects and spatial datasets is of fundamental importance for the data management in WISE. Principles of identifier management are given in the data specifications of INSPIRE[26] and also apply to WISE. This Chapter specifies the common framework for the unique identification of spatial objects and the concept for identifier management in WISE. It deals in with specific aspects of identifier management as regards reporting of spatial data by Member States and the development of WISE Reference GIS datasets. Definition of terms – unique identifier, code, etc. – used in this GIS guidance can be found in Chapter 1.3 and Appendix 14.

The application of unique identifiers to spatial objects contributes to data harmonisation. Data harmonisation has two aspects – harmonisation of the content (attributes, metadata) and harmonisation of geometry (horizontal and vertical level). For further detail see Chapter 6.1). Unique identification of spatial objects is necessary to harmonise the content. Furthermore, feature coding is an important component of the linkage between GIS datasets (object referencing).

4.4.2 WISE specific aspects

There will be four main types of datasets available in WISE (see Chapter 1.3): (1) Member State submitted GIS datasets; (2) WISE Reference GIS datasets; (3) Background GIS datasets; and (4) External GIS datasets. The framework for the unique identification of spatial objects provided in this GIS guidance applies primarily to the Member State submitted GIS datasets and the WISE Reference GIS datasets. Background and External GIS datasets will have – in the framework of INSPIRE – their own specifications for identifier management.

Furthermore the spatial feature available in WISE can be classified into:

- **Hydrological features;**
  - River basins and sub basins;
  - Rivers;
  - River segments (reaching from confluence to confluence);
  - Lakes.
- **Non-hydrological features;**
  - Management units such as River Basin Districts, Sub-units, water bodies, sensitive areas, etc;
  - Monitoring stations;
  - Features indicating point source pollution, such as discharge points, waste water treatment plants, etc;

[26] INSPIRE Generic Conceptual Model. D2.5, Version 3 (2008-06-20 ; Drafting Team « Data Specifications » - deliverable D2.6 : Methodology for the development of data specifications. Version 3 (2008-06-20)

- Features indicating pressure information, such as dams, weirs, etc;
- Protected Areas, bathing waters;
- …

Hydrological features should carry a unique **hydrological feature code**. Non-hydrological reference features should be assigned with a **non-hydrological unique object identifier** but should carry the code of the hydrological feature to which they are related as a foreign key.

The **hydrological feature code** is structured in a hydrological sense and takes the drainage system of a river network into account. It follows the principles of the Pfaffstetter coding. This enables rapid manual or automated analyses without the need to refer to GIS. Hierarchical structured coding also tends to ease long-term unique code maintenance.

The **Non-hydrological unique object identifier** should consist of two parts:

- A namespace to identify the data source. This namespace can also include entity type codes;
- A local identifier, assigned by the data provider. The local identifier should be unique within the namespace. It is the responsibility of the data provider to guarantee uniqueness of the local identifier within the namespace.

Further detail about the structure of the hydrological feature code and the non-hydrological unique object identifier are provided in Chapter 5.4.

An important aspect for WISE with regard to unique identifiers will be the **object referencing**[2]. Unique identifiers will be used as primary keys or foreign keys in geographical datasets and databases to allow the linkage of different spatial objects and to reference tabular information to their respective spatial object. Object referencing in WISE will be relevant:

- Between different GIS datasets submitted by Member States, both reported under one and different water related directives (e.g. WFD monitoring stations should be linked to WFD water bodies; sensitive areas reported under the UWWTD directive should be linked to water bodies reported under the WFD);
- Between Member State submitted GIS datasets and WISE Reference GIS datasets (e.g. Member States reported GIS data under WFD should be linked to the WISE Reference GIS dataset "River Basin Districts").

Furthermore the linkage of attribute information (descriptive data) to spatial objects will be relevant for the reporting process (e.g. information related to water bodies like status information to the geographic feature water body; water quality data reported under the SoE process to monitoring stations or water bodies reported under the WFD).

It is strongly recommended that unique identifiers should be provided for spatial objects where references from other spatial objects are expected to be applicable.

Information on how datasets refer to each other will be available in WISE. As soon as a Member State updates a dataset, WISE will send an automatic note to inform the Member State which datasets are related to the one that has been updated. The Member State is responsible for maintaining referential integrity between the related datasets.

4.4.3 Non-hydrological identifier - general requirements and recommendations

According to INSPIRE[27] unique identification of spatial objects is provided by external object identifiers, i.e. identifiers published by the responsible data provider. In case of WISE, the responsible data providers will be the Member States, the EEA with regard to the WISE Reference GIS datasets, and the providers of the Background and External datasets.

The following requirements and recommendations for identifier management are given:

Requirements:

Uniqueness: No two spatial objects of spatial object types shall have the same identifier. The identifier has to be unique within all the spatial objects published in WISE. The identifier shall not be used again if an object is modified.

The same spatial object shall be reported always using the same identifier (e.g. monitoring stations reported to SoE, WFD, Nitrates Directive, etc).

Persistence: The identifier has to remain unchanged during the life-time of a spatial object. If features are re-coded, links to historical data and links to data related to these features will be lost. The specification of every spatial object type shall state which modifications (e.g. attribute changes, merging with other spatial objects) may change the identity of a spatial object, i.e. when the existing object is "retired" and a new object with a new identifier is created. Lifecycle rules for spatial object types in a spatial dataset should be documented in the metadata of the dataset (see Appendix 11 for more details on metadata). It will not be necessary to copy the lifecycle rules to the metadata, a reference to a source that provides information is sufficient.

New identifiers may be created if:

- The location of a point features changes (e.g. if a monitoring station is moved upstream or downstream); threshold 125 m in accordance to the positional accuracy recommended for GIS datasets (according to the scale 1:250,000);
- The location or length of a line feature changes (e.g. if a river water body is divided or merged with another);
- The location or size of a polygon changes (e.g. if a groundwater body is divided or merged with another).

The rules for unique identifiers of spatial objects shall apply for spatial datasets, too.

Recommendations:

The identifier should be as short as possible to avoid typing mistakes, yet as long as is required to support unique code maintenance at local operational levels. Precise structures are a matter for each Member State to decide upon.

[27] INSPIRE Generic Conceptual Model. D2.5, Version 3 (2008-06-20)

4.4.4 WISE Reference GIS datasets

WISE Reference GIS datasets will be published by the EEA (see Chapter 3.1). One purpose of these datasets will be to provide a reference for reporting. Member State submitted GIS datasets will be referenced against European-wide harmonised GIS datasets, i.e. WISE Reference GIS datasets. This will facilitate harmonised analysis of reported data and data visualisation.

The EEA will be responsible for the unique identification of spatial objects within WISE Reference GIS datasets, guaranteeing persistence over time. For the time being, identifiers and codes will be developed and maintained at EC level for the following WISE Reference GIS datasets:

- **Hydrological features codes** of the WISE Reference GIS datasets;
    - Main rivers and main lakes (this will include also the coding of the river basins of main rivers and large rivers).
- **Non-hydrological identifiers** of the WISE Reference GIS datasets;
    - River Basin Districts;
    - Sub-units;
    - Water bodies.

The management of the identifiers and codes at European level will include:

- The publication of the identifiers/codes in WISE and the description of their development;
- The registration of the namespace used (including entity type codes if used);
- The description of life-cycle rules of the spatial objects of the WISE Reference GIS datasets;
- An explanation if identifiers/codes have been changed or new identifiers/codes have been created (e.g. change of RBDs or Sub-units) during an update. The respective WISE Reference GIS datasets will be provided to Member States via WISE in time for the next reporting period (including a documentation of new/changed objects/identifiers);
- The description how Member States should use the identifiers/code, including how the referencing of objects provided by Member States to the objects of the WISE Reference GIS datasets will be performed.

4.4.5 Member State submitted GIS data and historical data management

Member States are responsible for the unique identification of spatial objects reported to WISE and to guarantee persistence over time. This applies to the hydrological and non-hydrological features mentioned above. However two major problems arise on implementing these rules:

- Objects in the real world change over time. For example a monitoring station is removed from a network, River Basin Districts are restructured (due to changes in administrative boundaries), etc. Detailed guidelines are required on how to handle identifiers for these spatial cases.

- As the objects are changing over time this also means that foreign keys or references to other datasets may become obsolete.

Member States will be responsible for:

- Maintaining the references between national data submitted to WISE as required by the respective reporting guidelines and described in the WISE data model (e.g. sensitive areas reported under UWWTD linked to water bodies reported under WFD);
- Referencing their spatial objects to the respective objects of the WISE Reference GIS datasets and maintaining these references;
- Maintaining correct linkages between datasets where objects have changed or new objects have been created, and updating all related datasets accordingly (e.g. if a new river water body dataset is submitted, the river monitoring stations also have to be updated because the stations are linked to river water bodies).

4.4.6 Identifier management and object transaction

Depending on the data, the reporting obligations and the intended use of the data, it will be necessary to establish a system that manages temporal changes of non-hydrological features including the identification of predecessors and successors. Changes will occur from one reporting period to another (submission of datasets according to reporting deadlines) but also in between reporting periods (update/resubmission of datasets).

The following changes within GIS datasets are possible:

- Change of identifiers only (e.g. wrong identifier was provided, geometry remains unchanged);
- Change of geometry and identifiers (e.g. a water body is divided);
- Change of geometry only (e.g. wrong geometry was provided, identifiers remain unchanged).

The current situation of reporting to WISE is described in Figure 4.4.1. Sets of spatial object instances having an agreed structure are reported at fixed points in time (reporting deadlines). They describe the situation at a certain reference date. The spatial objects carry identifiers which are unique within the dataset.

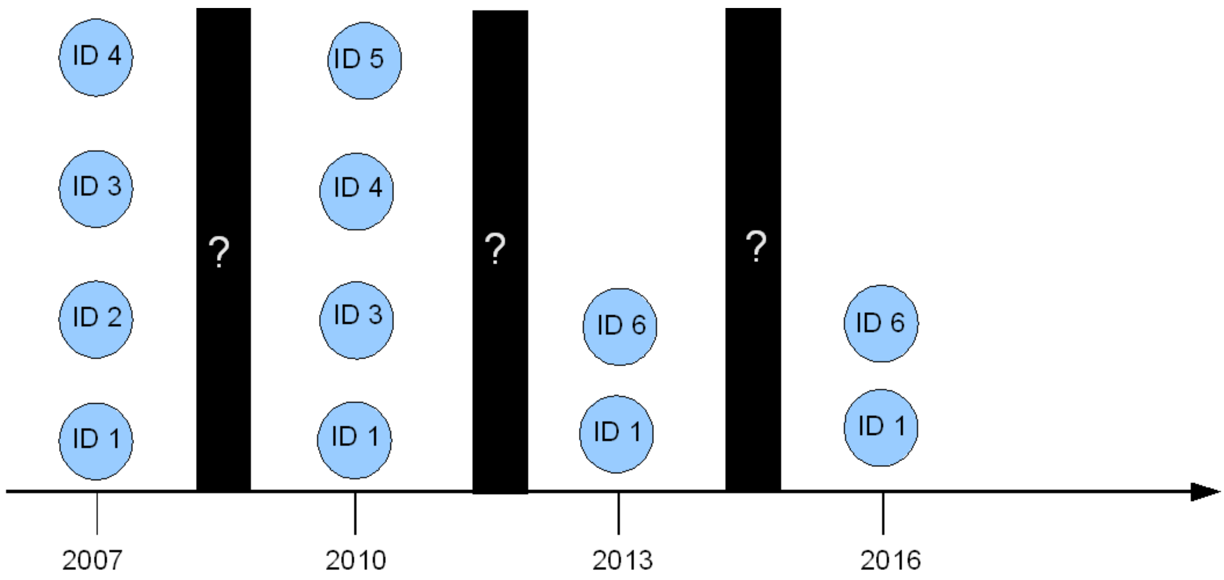


Figure 4.4.1 Time series information in existing reporting practices

Subsequent reporting cycles do not provide any explicit information on previously reported data, so the analysis of temporal development is mainly based on "best guesses", e.g. based on the invariance of names or locations. Analysis with on-going reporting exercises show that it is sometimes very difficult to link currently reported objects to objects reported in previous reporting cycles.

Information on temporal changes is needed for most of the data reported to WISE. WFD reporting demonstrates how data reported under different reporting obligations and at different dates are interlinked.

Example: WFD, water bodies – reporting of risk analysis 2005 and status 2010:

- In 2005 according to Article 5 of the WFD, water bodies at risk of failing to reach good status were reported;
- After this risk analysis, a monitoring network was put in place to obtain information on the status of the water bodies. The monitoring network was reported to WISE in 2007. At this time the first reference to historic data was made. The monitoring stations had to be linked to 2005 reported water bodies. If water bodies changed from 2005 to 2007, the water body dataset should have been updated as well;
- In 2010 the status of water bodies will be reported to WISE. According to the WFD it is necessary to analyse the status of water bodies previously reported in 2005. This can only be done if linkages can be made between the datasets and any changes made to water bodies between 2005 and 2010 are also reported.

Thus the data and update cycles needed to maintain a complete, historic view of the data are dependent on the level of the "temporal coupling" required in WISE. In future WISE should allow the tracking of changes between different data submissions, resubmissions and updates (see Figure 4.4.2 on the proposed history management in WISE).

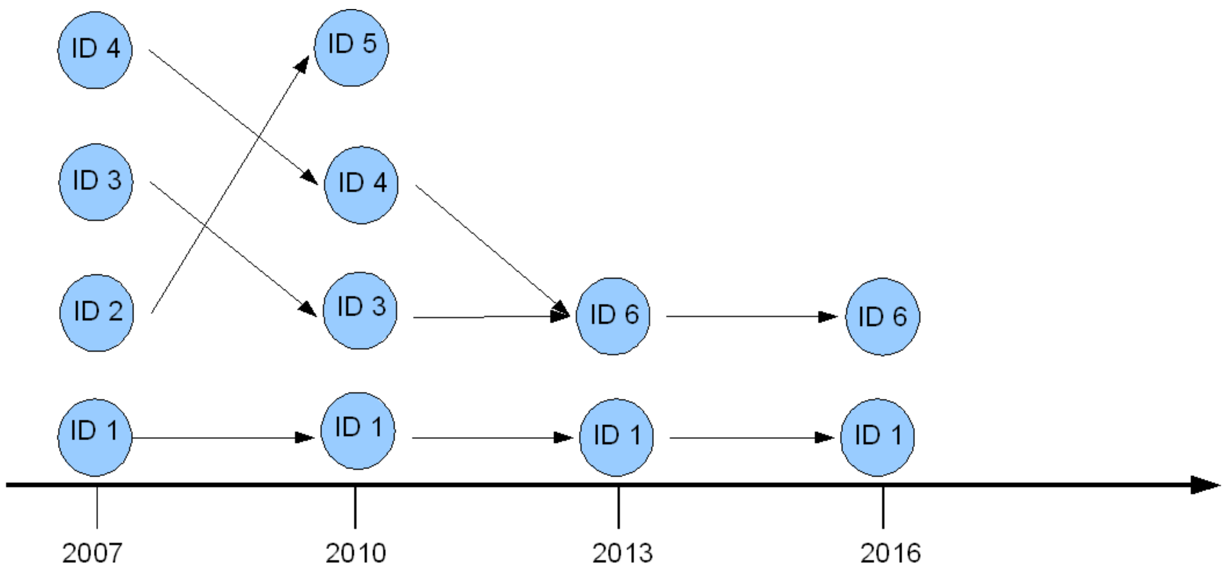


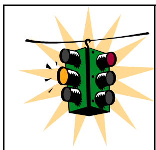
Figure 4.4.2 Proposed history management in WISE

Several concepts exist relating to historic data management and these are described in Appendix 09. In principle either predecessors or successors can be identified. Within each WISE reporting process it should be defined whether historic data management of GIS data is necessary and how this will be achieved. The data model and dataflow should be developed accordingly.

TECHNICAL CHAPTERS

5 Technical Descriptions

5.1 General approach for definition of datasets



Look out! Guidance may change as INSPIRE and WISE develop

This Chapter has been developed in parallel with INSPIRE developments and discussions at COM and EEA on the implementation of INSPIRE recommendations in WISE. The content and advice may thus change as INSPIRE and WISE develop.

5.1.1 How to develop the data specifications

The WISE data specifications are targeted towards meeting the needs of a wide audience and should fulfill legal requirements as well as from the GIS technical side. The specifications should be sufficiently unambiguous so when they are applied by GIS specialists throughout Europe they lead to harmonised datasets which, with minimal additional effort, can be viewed and analysed in a comparable way.

INSPIRE is targeted towards providing Europe with a spatial data infrastructure. INSPIRE is developing guidance for the data specification process. The INSPIRE drafting team “Data Specifications” has issued a document “Generic Conceptual Model”[28]. The following figure (Figure 5.1.1) from ISO 19109 (“From reality to geographic data”) illustrates the modeling process.

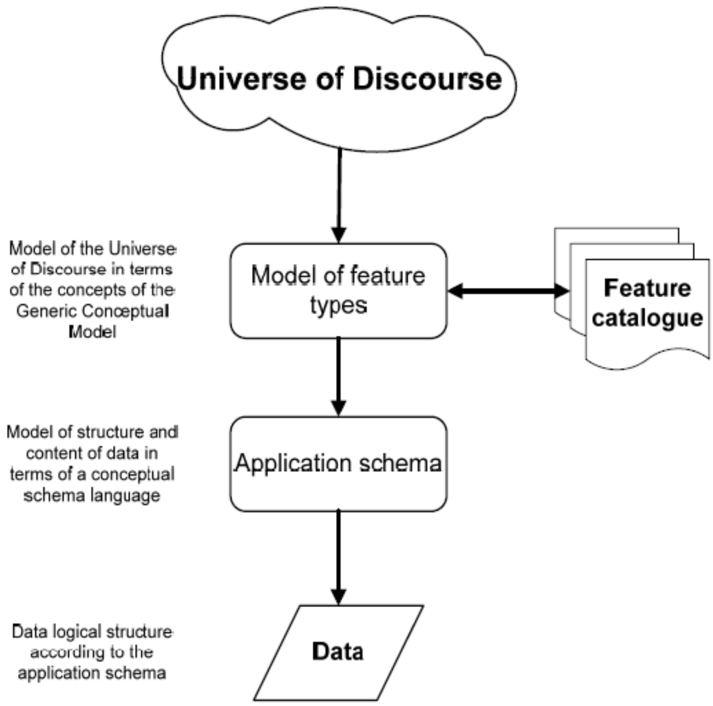


Figure 5.1.1 Data modelling process (from ISO 19109)

[28] http://www.ec-gis.org/inspire/reports/ImplementingRules/inspireDataspecD2_5v2.0.pdf

5.1.1.1 Universe of Discourse

The data modeling process originates in the concepts found in the area of interest described as the “Universe of Discourse”. The concepts are found for example by text analysis of the legislation. The target for WISE application of the developed spatial data is however wider than reporting purely for documentation of legal compliance. The wider applicability thus requires more than a simple analysis of legal texts.

5.1.1.2 Conceptual model

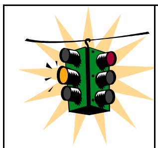
The conceptual model should include all the concepts (not only spatial objects) and their properties (attributes, operations and the relationships that exist among the objects). In this part of the modeling process, the focus is on common understanding and agreement of the concepts (features) involved including the level of details needed (resolution) and the relationships between the concepts. In this phase there are no considerations about technical detail of delivery etc. The WISE outputs from this phase are Reporting sheets (first drafts of feature catalogues) and UML overview diagrams.

5.1.1.3 Application schema

When a common understanding of the concepts involved has been agreed, the application schema may be developed. The application schema is a rigorous description of how the Universe of Discourse should be described as data. The application schema takes the form of UML static structure diagrams (class diagrams) supported by data specifications and a data dictionary. The “INSPIRE Generic Conceptual Model” recommends to express the constraints in OCL (Object Constraint Language) and include them in the UML diagrams. Although preferable for the long term implementation in WISE data flows, the UML diagrams in this guidance do not include constraints.

5.1.1.4 Reporting schemas

The application schema may also be converted and expressed in the logical form specifying the structure for (for example) reporting the data. The WISE reporting schemas have so far taken the simple approach of ESRI shape file templates. Geography Markup Language (GML) may be an alternative to express the reporting schemas in a vendor independent form. GML would be a requirement for compliance with INSPIRE.



Look out! The format of reporting GIS may change

The change to GML schemas is to be confirmed, (see Chapter 5.6)

The INSPIRE drafting team "Data specification" has issued a draft document "Methodology for the development of INSPIRE data specifications[29], which provide further details of the data specification process.

5.1.2 Principles to be applied during data specification work

Article 8 of the INSPIRE Directive provides a set of principles (see text box below) to be applied in the INSPIRE context when defining implementing rules (data specifications) of INSPIRE Annex I and Annex II data. Furthermore, the document "INSPIRE Generic Conceptual model" recommends to apply a "keep it simple" approach to the development of rules for data specifications. Simplicity should be the focus in particular for two aspects:

- The processing and use of (INSPIRE) data should be as simple as possible for users and their software applications.
- For data providers, the transforming/harmonising of their existing data sets should be as simple as possible.

> INSPIRE Article 8:
>
> *1. In the case of spatial data sets corresponding to one or more of the themes listed in Annex I or II, the implementing rules provided for in Article 7(1) shall meet the conditions laid down in paragraphs 2, 3 and 4 of this Article.*
>
> *2. The implementing rules shall address the following aspects of spatial data:*
>
> *(a) a common framework for the unique identification of spatial objects, to which identifiers under national systems can be mapped in order to ensure interoperability between them;*
>
> *(b) the relationship between spatial objects;*
>
> *(c) the key attributes and the corresponding multilingual thesauri commonly required for policies which may have an impact on the environment;*
>
> *(d) information on the temporal dimension of the data;*
>
> *(e) updates of the data."*
>
> *3. The implementing rules shall be designed to ensure consistency between items of information which refer to the same location or between items of information which refer to the same object represented at different scales."*
>
> *4. The implementing rules shall be designed to ensure that information derived from different spatial data sets is comparable as regards the aspects referred to in Article 7(4) and in paragraph 2 of this Article."*

[29] http://www.ec-gis.org/inspire/reports/ImplementingRules/inspireDataspecD2_6v2.0.pdf

The "INSPIRE Generic Conceptual Model" also recognises that a major part of INSPIRE data specifications will be the result of a harmonisation process based on existing data specifications. The situation regarding WISE data will, to large extent, also be based on the harmonisation of existing data.

From the first years of WFD implementation a number of useful principles can be provided which help a smoother process of data specification. The principles include:

- Use UML models for communicating the relationship between concepts. The UML modelling (graphic) language is becoming a de facto standard, which is also recommended by INSPIRE guidance documents. The graphic models present the complex relationships in a simple way to an audience with a non-technical background. The UML models help in analysing the relationships between data;
- Be clear and explicit in describing the intended content. In areas where different communities apply a similar terminology and/or set of concepts, confusion may arise from the fact that the perception and interpretation of the concept may originate in different approaches. The perspective on a particular concept will be different depending on the tradition of application. The *implicit* understanding of a concept by each party may thus be different and should be made *explicit*. If ambiguity of terms is suspected the semantics should be supported with clear rules for (for example) data capture and validation;
- Clarify expected resolution and spatial properties. As a major part of the (harmonised) data in question will originate from existing data collections, the issue of data capture is very important. If only a subset of a particular feature class is expected the selection criteria should be specified. Similarly, if the set of features is expected to have certain application properties, e.g. main rivers are expected to be connected through lakes and artificial stretches (canals) and have an outlet at the coastline;
- Be clear on how the object will be identified (primary identifier). Each object should have at least one persistent unique identifier. The identifiers should be of data type text string. Although slower in matching and indexing, the use of text string prevents problems with different numerical encoding;
- Consider the separation of the geometry and primary identifier from other attributes in reporting specifications;
- Keep the spatial feature class slim. Usually several attributes may be assigned to a specific feature class. Care should be taken that only stable attributes are included in the class. Attributes describing a state or a classification subject to a potential change should be modelled in separate tables and linked through unique identifiers. In a similar way, attributes which can be deduced from spatial relationships with other spatial objects should be avoided. During a reporting delivery cycle some redundant information may be included for verification purposes;
- Attribute names should be informative;

- Codelists for attributes should be applied to the maximum extent possible. Wherever possible attribute domains should be enumerated and explained to reduce ambiguity;
- When an attribute contains geographic names, the language as well as the character set allowed should be made clear.

5.1.3 General specifications

5.1.3.1 Spatial reference system

The use of a common geodetic datum (horizontal and vertical) is a first step towards the harmonisation of geographic information across Europe. The adoption of a common reference system makes it possible to maintain seamless distributed spatial data set, assigned to different custodians and avoiding or simplifying the work of geometric harmonisation. A common geodetic datum is particularly important for GIS users who require a seamless dataset. Furthermore, the fact that spatial data provided by Member States is often insufficiently documented (e.g., the used Datum may be unknown or only partially or ambiguously described), is a source of error when national data are converted to a European system. To avoid these problems, it will be the responsibility of Member States to provide data according to the proposed European datum.

ETRS89[30] is recognised by the scientific community as the most appropriate European geodetic datum to be adopted. It is defined to 1cm accuracy, and is consistent with the global ITRS[31]. ETRS89 is now available due to the creation of the EUREF[32] permanent GPS station network and the validated EUREF observations.

For islands not belonging to the European continental landmass the use of ETRS89 may not be applicable. For those areas the WGS84 (World Geodetic System 1984) should be used as the geodetic datum.

The IAG[33] sub-commission for Europe (EUREF) has defined a European vertical datum based on the EUVN[34] /UELN[35] initiative. The datum is named the EVRS[36] and is realised by the EVRF2000.This vertical datum should be applied for deliveries requiring absolute 3-D coordinates.

The National Mapping Agencies (NMA) (or comparable institutions and organisations) provided the information for the descriptions of the national Coordinate Reference Systems and for the transformation parameters between the national Coordinate Reference Systems and the European Coordinate Reference System ETRS89. Formulae can be requested from the NMAs or are directly accessible at http://crs.bkg.bund.de/crs-eu/.

[30] ETRS : European Terrestrial Reference System; EPGS code 3035, http://www.epsg-registry.org/
[31] ITRS : IERS Terrestrial Reference System (IERS : International Earth Rotation Service)
[32] EUREF : European Reference Frame
[33] IAG : International Association of Geodesy
[34] EUVN : European Vertical Reference Network
[35] UELN : United European Levelling Network
[36] EVRS : European Vertical Reference System

We make the following recommendations:

Spatial Reference System:

- To adopt ETRS89[37] as geodetic datum and to express and store positions in ellipsoidal co-ordinates (decimal degrees), with the underlying GRS80 ellipsoid [ETRS89];
- To use the official formulae provided by NMAs or comparable National Institutions for the transformation between National Co-ordinate Reference systems and the ETRS89;
- To document National Co-ordinate Reference systems according to ISO19111;
- To further adopt EVRF2000 for expressing practical heights (gravity-related).

5.1.3.2 Geometric representation

The spatial features may be represented using simple geometry types only (i.e. points, lines, polygons). Optionally, a part of the same set of real world entities could be modeled as a simple or complex network.

Linear referencing systems and topologic networks are supported in some GIS systems and have been applied in several Member States. The implementation may be performed in several ways and the exchange of data between systems is not yet adequately supported. Although the two data structures have many benefits in data management as well as spatial analysis, the application of linear referencing and topologic network is thus not recommended for the data specification work inside WISE.

Network analysis may however be supported using the hydrological feature coding approach described in Chapter 5.4, provided that the simple lines reported are geometrically connected (node to node). Needs for later network analysis should be reflected in the topology rules in the specific data specifications.

When specifying the spatial properties in the application schema it is recommended to apply only the following simple geometry types (See Table 5.1.3.2, from ISO 19107 Geographic Information –Spatial Schema”).

Table 5.1.3.2 Recommended ISO Geometry types

ISO Geometry types	Description
GM_Point	Single point features
GM_MultiPoint	Multi-point features
GM_LineSegment	A line-segment between two vertices
GM_LineString	A line composed of simple line-segments
GM_Polygon	Polygon features

[37] Except for islands out of the European continental landmass, here WGS84 should be applied.

5.1.3.3 Scale, resolution and positional accuracy

When specifying the spatial data characteristics, the (recommended) scale of the visualisation of data can be regarded as an indicator of the resolution (which level of detail is available for map making). In the WISE context, where data mainly are based on harmonisation of existing, more accurate, national data, the traditional perspective of the scale as an indicator of positional accuracy (which is the possible difference between the true real world co-ordinates and the co-ordinates of the data) is less relevant though positional accuracy by itself is very important.

The resolution determines both the size of the smallest object in the data set and the amount of detail that might be discerned. On a large scale map (i.e. 1:250.000) a river is presented with more points than on a small scale map (i.e. 1:1.000.000), where, for example, small meanders may not be visible. While in theory a dataset at 1:1.000.000 scale might cover the same set of entities (objects) as a dataset at 1:250.000 scale, the latter can present the information in a better way (i.e. the positional accuracy is higher and the shapes of the entities are represented more accurately). Showing a dataset intended for large scale use e.g. 1:50.000 of a meandering stream together with a dataset with an intended scale of 1:250.000 without prior generalisation will emphasise the large scale data. The large scale streams give the impression of being drawn with a broader (but uneven) line symbol. The generalisation rules may be defined as “the features should be registered by as few co-ordinate pairs as possible, though the distance between a vertex and the true position of the feature should never exceed 125 metres”. The value of 125 metres can be considered as the simplification tolerance.

Member States are recommended not to simplify spatial data before submitting to WISE. The accuracy of the data should however be documented in the metadata so the simplification process performed in WISE during e.g. reference data production can respect the original accuracy.

If linear or area entities are represented as points (centroids) these should be ‘geometric’ centroids in the sense that the point should fall inside a polygon representation or for linear features be a point on the line. It is generally recommended not to apply centroids as the representation for features. Whether a given entity is at all represented in a data set is specified by the harmonisation component “Data Capture.”

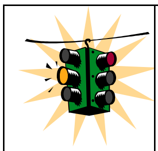
The generally agreed scale of presentation in WISE ranges from 1:250.000 to 1:10.000.000.

The following table (Table 5.1.3.3) shows the relationships between scale, resolution, simplification tolerance and spatial (positional) accuracy.

Table 5.1.3.3 The relationship between scale, resolution, simplification tolerance and spatial accuracy

Scale	**Resolution**	**Simplification tolerance**	**Spatial accuracy**
1:250.000	0.5 km^2	125 metres	125 metres
1:1.000.000	8 km^2	500 metres	500 metres

1:10.000.000	800 km^2	5000 metres	5000 metres



Look out! The requirement for accuracy has been modified

The previous guidance document had a spatial accuracy of 1000 metres. It has been evaluated that the accuracy of the spatial datasets have improved and an accuracy better than 500 metres may be expected.

Considering both the WISE needs and the practical constraints of data availability, the GIS Working Group recommended that the required positional accuracy for reported data should be better than 125 metres. The positional accuracy should always be kept as high as possible and ideally be similar to the national operational datasets.

5.1.4 Data layer characteristics

From the "INSPIRE Generic Conceptual Model" an overview of necessary harmonisation components can be provided, see Figure 5.1.4. Each of the harmonisation components contributes with a specific element to the data specifications. Table 5.1.4 further elaborates the scope of each of the harmonisation components.

For the development of WISE GIS data specifications, (see Chapters 5.2 and 5.3 and Appendices 05 and 06) a subset of the component are considered. For some of the component a few decisions cover all WISE layers. As an example, the previous GIS guidance (as well as the current) recommends to adopt ETRS89 as the geodetic datum and to express and store positions, as far as possible, in ellipsoidal coordinates, with the underlying GRS80 ellipsoid [ETRS89]. This is a part of the general specifications which (partly) fulfil the component "(G) Coordinate referencing and units model".

Other harmonisation components are considered in Chapters 5.4 to 5.7 and 6.1.

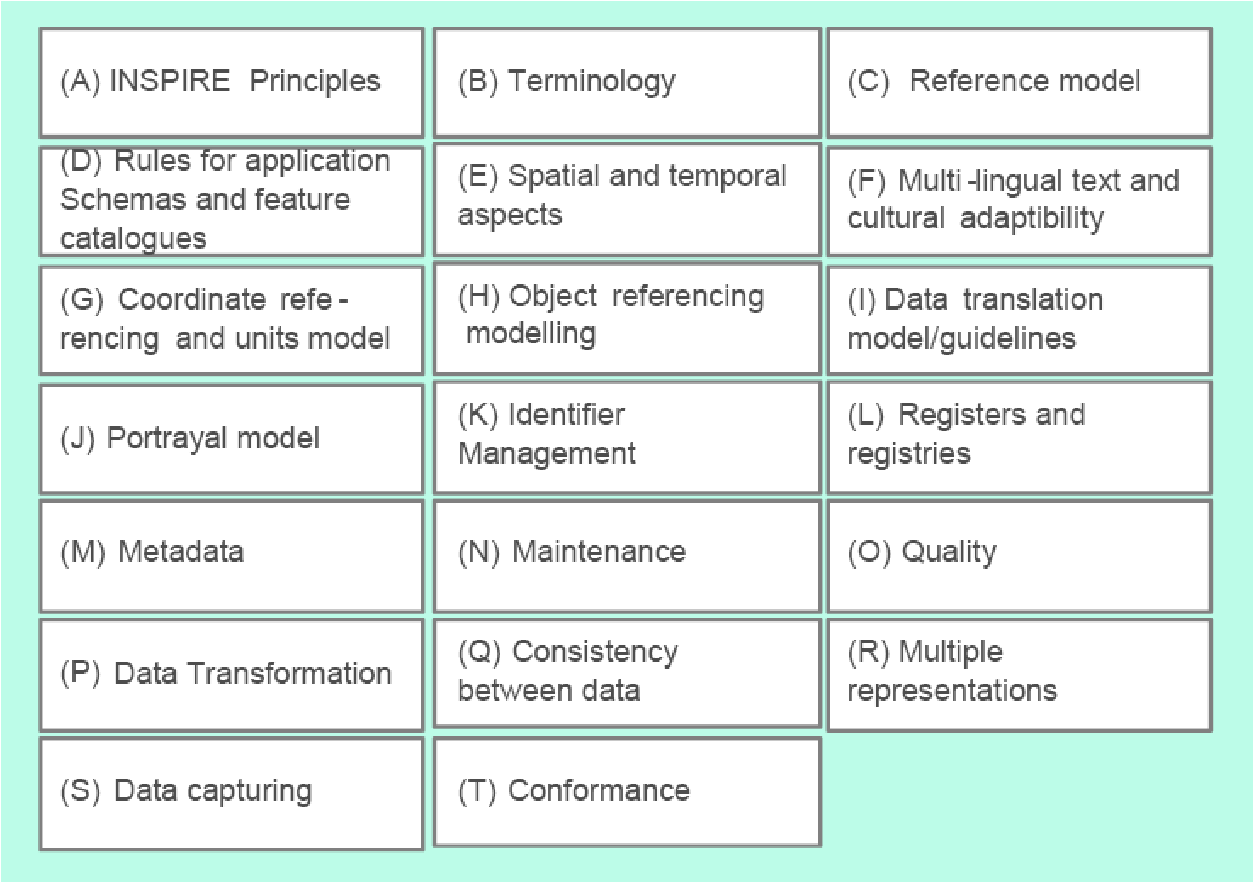


Figure 5.1.4 Data Harmonisation Components from INSPIRE D2.5 Generic Conceptual Model

Table 5.1.4 Scope of INSPIRE harmonisation components from INSPIRE D2.5 Generic Conceptual Model

Component	**Description**
(A) Principles	The principles cited in recital (6) of the Directive are considered to be a general basis for developing the data harmonisation needs. The first three of the five principles are to be considered to help define the data harmonisation process: • *That spatial data are stored, made available and maintained at the most appropriate level;* • *That it is possible to combine spatial data from different sources across the Community in a consistent way and share them between several users and applications;* • *That it is possible for spatial data collected at one level of public authority to be shared between other public authorities.*
(B) Terminology	This component will support the use of a consistent language when referring to terms via a glossary. This needs to be registered and managed through change control with multi-lingual support. The ESDI needs to select a common terminology from all of the existing terminologies and/or their translations.
(C) Reference model	This component will define the framework of the technical parts including topics like information modelling (i.e. conceptual modelling framework with rules for application schemas) and data administration (i.e. reference systems). It will provide a structure which allows the components of INSPIRE which are related to data specifications to be described in a consistent manner.
(D) Rules for application schemas and feature catalogues	The purpose of this component is to • Provide a computer-readable data description defining the data structure - enabling automated mechanisms for data management; • Achieve a common and correct understanding of the data, by documenting the data content of the particular theme, thereby making it possible to unambiguously retrieve information from the data. Feature catalogues define the types of spatial objects and their properties (attributes, association roles, operations) as well as constraints and are indispensable to turning the data into usable information. Feature catalogues promote the dissemination, sharing, and use of geographic data through providing a better understanding of the content and meaning of the data. The full description of the contents and structure of a spatial dataset is given by the application schema which is expressed in a formal conceptual schema language. The feature catalogue defines the meaning of the spatial object types and their properties specified in the application schema. Text elements in the feature catalogues should be maintained at least

<table>
<tr><td></td><td>in the official European languages.</td></tr>
<tr><td>(E) Spatial and temporal aspects</td><td>Conceptual schema for describing the spatial and temporal characteristics of spatial objects:

Spatial geometry and topology;
Temporal geometry and topology;
Coverages (examples of coverages include rasters, triangulated irregular networks, point coverages, and polygon coverages);
etc.

While the component "reference model" specifies an overall framework, this component deals with the spatial and temporal aspects in more detail, for example, the types of spatial or temporal geometry that may be used to describe the spatial and temporal characteristics of a spatial object.</td></tr>
<tr><td>(F) Multi-lingual text and cultural adaptability</td><td>Conceptual schema for multi-lingual character strings in spatial objects and supporting information:

To be used in all application schemas and as a result in data instances: all string valued properties that may be provided in a language shall use this type;
To be used in the dictionary model so that dictionaries may be multi-lingual, e.g. the feature catalogue, the feature concept dictionary or codelists.

Since the feature catalogue and the feature concept dictionary are multilingual, the definition and names of all spatial object types, their attributes/associations and their attribute values provided by enumerations/codelists are multi-lingual. So far representation of constraints in the different languages has not been formally required, but such a requirement may be added in the future.

At the moment, it is not planned to document the formal application</td></tr>
</table>

	schema (classes, attributes, associations, constraints) in multiple languages as the definitions are part of the feature catalogue and data dictionary. In principle, cultural differences have to be taken into account, e.g. not all terms may be translatable from one language to another. Furthermore, cultural differences between communities working in the same language can be at least as much a problem as multi-lingual issues. Ontologies may help to capture multi-cultural aspects.
(G) Coordinate referencing and units of measurement model	This component will describe methods for spatial and temporal reference systems as well as units of measurements – including the parameters of transformations and conversions. The focus is on reference systems that are valid across Europe (in case of projected systems split into zones this will be a collection of such systems covering the different zones). This component will also support European geographical grids.
(H) Object referencing modelling	This component will describe how information is referenced to existing objects, typically base topographic objects, rather than directly via coordinates. It will be specified how the spatial characteristics of a spatial object can be based on already existing spatial objects. As a result, this component will support the generation and maintenance of application-specific “user geographies” based on reference data. The aim is to promote the easy and reliable exchange of data that is associated with spatial objects (e.g. river quality sample records) across several users who use a common base (thus avoiding spatial inconsistencies and massive data transfers to support regular reporting).The approach improve data integrity across distributed systems and services as well as more reliable data sharing. Object referencing is especially relevant in referencing spatial objects of Annex III themes to those of the themes in Annex I and II.
(I) Data translation model / guidelines	This component is about translating from a national/local application schema to the INSPIRE application schema and vice versa. Translations are required for data and for queries. NOTE No well-defined set of translation capabilities has been standardised in the GI community at this time. It is not yet clear, if there will be a need to specify translations also between different European application schemas, e.g. for different representations or for creating specific information products, e.g. for reports or from base data etc. Also, further research would be required to identify how consistent adoption of ontologies could be exploited here.
(J) Portrayal model	This component will define a model for portrayal rules for data according to a data specification. It will clarify how standardised portrayal catalogues can be used to harmonise the portrayal of data.
(K) Identifier management	Spatial objects from Annexes I and II should have an external object identifier. This component will define the role and nature of unique object identifiers (or other mechanisms) to support unambiguous

	object identification. To ensure uniqueness some form of management system will be required. This does not mean that all organisations need to adopt a common form of identifier or other mechanism but the identifier management mechanisms (e.g. registers) in use at national level will need to be synchronised/mapped to ensure pan European integration. Note that the same real-world phenomenon may be represented by different spatial objects (with their own identifiers).
(L) Registers and Registries	Registers will at least be required for: • All reference systems used in spatial data sets; • All units of measurement used in spatial data sets; • All codelists / thesauri used in the application schemas (multi-lingual, at least in all official European languages); • The feature concept dictionary for elements used by application schemas (multi-lingual, at least in all official European languages); • Identifier namespaces; • All feature catalogues; • All application schemas. The registries will be available through registry services. Metadata on dataset level will be available through catalogue services.
(M) Metadata	This component will cover metadata on the following levels: • Discovery; • Evaluation; • Use. Metadata associated with individual spatial objects will in general be described as part of the application schemas.
(N) Maintenance	This component will define best practice in ensuring that application data can be managed against updates of reference information without interruption of services. This will require the definition of mechanisms by different stakeholder areas to manage where this is required and it is feasible: • Change only updates; • Versioning of objects (and their properties); • Object lifecycles. Propagation of changes across scale and between dependent objects is required in general to maintain consistency of the data (automatic or manual processes).
(O) Data & information quality	This component will advise the need to publish quality levels of each spatial dataset using the criteria defined in the ISO 19100 series of standards, including completeness, consistency, currency and

	accuracy. This will include methods of best practice in publishing: • Acceptable quality levels of each spatial dataset; • Attainment against those levels for each spatial dataset. Quality information associated with individual spatial objects is part of the metadata associated with the respective spatial object (see component "Metadata") and will in general be described as part of the application schemas.
(P) Data transfer	This component will describe methods for encoding application and reference data as well as information products. The encoding of spatial objects will in general be model-driven, i.e. fully determined by the application schema in UML. To support network services that are implemented as web services, spatial objects are expected to be primarily encoded in XML/GML for the exchange of spatial data. Coverage data is expected to use existing encodings for the range part.
(Q) Consistency between data	This component will describe guidelines how the consistency between the representation of the same entity in different spatial datasets (for example along or across borders, themes, sectors or at different resolutions) shall be maintained. The custodians of such spatial datasets will decide by mutual consent on the depiction and position of such common spatial objects or they will agree on a general method for edge-matching or other automatic means to maintain data consistency.
(R) Multiple representations	This component will describe best practices how data can be aggregated: • Across time and space; • Across different resolutions ("generalisation" of data). Such aggregation processes are used in particular to create the following results: • Multiple representations; • Derived reporting (example: typically water samples at 1 km intervals are reported to the European level).
(S) Data capturing rules	This component will describe the data specification-specific criteria regarding *which* spatial objects are to be captured and which locations/points will captured to represent the given spatial object (e.g. all lakes larger than 2 ha, all roads of the Trans European Road Network, etc.). For INSPIRE data specifications it is in general not relevant, *how* the data is captured by the data providers.
(T) Conformance	This component will describe how conformance of data to a data specification is tested, i.e. it will be necessary to apply conformance tests as specified in the individual data specification. Ideally these will be automated.

	In addition, all INSPIRE data specifications will conform to the Generic Conceptual Model as well as, since Data Specifications are specified using ISO 19131 (Data product specification), to ISO 19131.

5.2 Overview of the GIS layers and their relationships

5.2.1 Overview of GIS layers

WISE provides a repository for a wide range of GIS datasets. These datasets include those compiled by Member States for regulatory reporting and for other voluntary purposes as well as the WISE Reference GIS datasets.

Each set of data is termed a theme. The themes within WISE are:

1. **WISE Reference GIS datasets***
2. **Member State submitted GIS datasets, including data relating to:**
   - Water Framework Directive;
   - State of the Environment Reporting (WISE-SoE);
   - Urban Waste Water Treatment Directive;
   - Bathing Waters Directive;
   - Nitrates Directive*;
   - Drinking Water Directive*;
   - Floods Directive*;
   - Marine Strategy Directive*;
   - E-PRTR.*

* Data models are not yet available for these themes.

The WISE viewer also accommodates a number of background and external GIS data sets – a list of these datasets may be found in Appendix 05.

Further details of the GIS layers in each theme are provided below. The availability in WISE indicates when data have been accepted and entered into the WISE production data bases.

An updated list of publicly visible layers can be found at: http://www.eea.europa.eu/themes/water/mapviewers.

5.2.1.1 WISE Reference GIS datasets (based on WFD reporting)

Layer Code	Layer Name	Feature Type	Availability in WISE
Large Rivers and Large Lakes			
REF1a	Large Rivers	Line	2007
REF1b	Large Lakes	Polygon	2007
Main Rivers and Main Lakes			
REF2a	Main Rivers	Line	2009
REF2b	Main Lakes	Polygon	2009

Layer Code	Layer Name	Feature Type	Availability in WISE
Water Bodies			
REF3a	River Water Bodies	Line/Point	2007
REF3b	Lake Water Bodies	Polygon/Point	2007
REF3c	Transitional Water Bodies	Polygon/Point	2007
REF3d	Coastal Water Bodies	Polygon/Point	2007
REF3e	Groundwater Bodies	Polygon/Point	2007
River Basin Districts			
REF4	River Basin Districts	Polygon	2007
Sub-units			
REF5	Sub-units	Polygon	2009

5.2.1.2 Member State submitted GIS datasets

- **Water Framework Directive**

Layer Code	Layer Name	Feature Type	Availability in WISE
Article 3			
WFD_RBD1	River Basin Districts	Polygon	2007
WFD_RB1	River Basin, Sub-basin	Polygon	Not yet available but reported
WFD_SW1a	Main River	Line	Part of REF2A
WFD_SW1b	Main Lakes	Polygon	Part of REF2B
WFD_SW1c	Transitional Waters	Polygon	Part of REF4
WFD_SW1d	Coastal Waters	Polygon	Part of REF4
WFD_GW1	Groundwaters	Polygon	Part of REF4
WFD_CA1	Competent Authorities	Point	2007
Article 5			
WFD_SW2a	River Water Bodies	Line/Point	2007
WFD_SW2b	Lake Water Bodies	Polygon/Point	2007

Layer Code	Layer Name	Feature Type	Availability in WISE
WFD_SW2c	Transitional Water Bodies	Polygon/Point	2007
WFD_SW2d	Coastal Water Bodies	Polygon/Point	2007
WFD_GW2	Groundwater Bodies	Polygon	2007
WFD_PA1	Drinking Water Protected Areas	Polygon	Not yet available but reported
WFD_PA2	Economically Significant Aquatic Species Protected Areas	Polygon	Not yet available but reported
WFD_PA3	Recreational Waters Protected Areas	Point	Not yet available but reported
WFD_PA4	Nutrient-Sensitive Protected Areas[38]	Polygon	Not yet available but reported
WFD_PA5	Habitats Protected Areas	Polygon	Not yet available but reported
WFD_PA6	Birds Protected Areas	Polygon	Not yet available but reported
Articles 7 and 8			
WFD_SW3a	Operational Monitoring Sites	Point	2008
WFD_SW3b	Surveillance Monitoring Sites	Point	2008
WFD_SW3c	Drinking Water Abstraction Points from Surface Water	Point	Not yet available
WFD_SW3d	Investigative Monitoring Sites	Point	Not yet available but reported
WFD_SW3e	Reference Monitoring Sites	Point	2008
WFD_GW3a	Groundwater Monitoring Network	Point	2008
WFD_GW3b	Operational Monitoring Network Chemical	Point	2008

[38] Nutrient sensitive protected areas means sensitive areas and their catchments falling under Urban Waste Water Treatment Directive (91/271/EEC), and Nutrient Vulnerable Zones falling under Nitrates Directive (91/676/EEC). It shall be ensured that if these are reported under UWWTD and NiD there will be no request for reporting those under WFD (2000/60/EC), as the reported geo-data/files will have the same requirements/structure for reporting and the link between UWWTD and WFD and NiD and WFD will be clearly identified by the Member States when reporting both ways (for WFD or NiD&UWWTD).

Layer Code	Layer Name	Feature Type	Availability in WISE
WFD_GW3c	Surveillance Monitoring Network Chemical	Point	2008
Other data requested by the European Commission			
WFD_SU1	Sub-units	Polygon	2009
WFD_ECO1	Ecoregions	Polygon	Not yet available but reported

- **State of the Environment Reporting (WISE-SoE)**

Layer Code	Layer Name	Feature Type	Availability in WISE
SOE1	WISE-SoE River Stations	Point	Yearly
SOE2	WISE-SoE Lake Stations	Point	Yearly
SOE3	WISE-SoE Quantity Stations	Point	Yearly
SOE4a	WISE-SoE Transitional, Coastal and Marine Water Stations	Point	Yearly
SOE4b	WISE-SoE Transitional, Coastal and Marine Water Flux Stations	Point	Not yet available
SOE5a	WISE-SoE Groundwater Bodies	Polygon	Not yet available but reported
SOE5b	WISE-SoE Groundwater Sampling Sites	Point	Not yet available
SOE5c	WISE-SoE Groundwater Saltwater Intrusion	Polygon/Point	Not yet available but reported

- **Urban Waste Water Treatment Directive**

Layer Code	Layer Name	Feature Type[39]	Availability in WISE[40]
UWWT1	Agglomerations	Point	2008
UWWT2	Urban Waste Water Treatment Plants	Point	2008

[39] Point feature types (e.g. agglomerations, treatment plants, discharge points) layer can be generated from the tabular data (coordinates) provided by the Member State when reporting under UWWTD
[40] Geo-data in sense of the Shapefiles of sensitive areas and their catchments was requested by the Commission for the first time in UWWTD questionnaire of 2007 for the reference year 2005 or 2006 (Member States could choose the reference year to report).

Layer Code	Layer Name	Feature Type[39]	Availability in WISE[40]
UWWT3	Discharge Points	Point	Not yet available but reported
UWWT4	Sensitive Area - River	Line	Not yet available but reported
UWWT5	Sensitive Area - Lake	Polygon	Not yet available but reported
UWWT6	Sensitive Area – Coastline	Line	Not yet available but reported
UWWT7	Sensitive Area – Coast Area	Polygon	Not yet available but reported
UWWT8	Sensitive Area – Transitional Water	Polygon	Not yet available but reported
UWWT9	Sensitive Area - Catchment	Polygon	Not yet available but reported
UWWT10	Less Sensitive Area – Transitional Water	Polygon	Not yet available but reported
UWWT11	Less Sensitive Area - Coastline	Polygon	Not yet available but reported

- **Bathing Waters Directive**

Layer Code	Layer Name	Feature Type	Availability in WISE
BWD1	Bathing Waters	Polygon[41]	Not yet available
BWD2	Sampling Points	Point	Yearly

- **Drinking Water Directive**

Layer Code	Layer Name	Feature Type	Availability in WISE
DWD1	Water Supply Zones	Polygon[42]	Not yet available

- **Nitrates Directive**

Layer Code	Layer Name	Feature Type	Availability in WISE

[41] Currently not available yet, and not requested yet.
[42] The coordinates of WSZ or the polygons of these zones are/will not be requested until 2010.

Layer Code	Layer Name	Feature Type	Availability in WISE
NID1	Nitrate Vulnerable Zones	Polygon	Not yet available
NID2	Monitoring Zones on Surface Waters	Polygon	Not yet available

- **Floods Directive**

Layer Code	Layer Name	Feature Type	Availability in WISE
FLD1	Flood Risk Zones	Polygon	Not yet available
FLD2	Extent of Past Flooding Events	Polygon	Not yet available
FLD3	Damage Maps	Polygon	Not yet available

- **Marine Strategy Directive**

Layer Code	Layer Name	Feature Type	Availability in WISE
MSD1a	Coastline 3 miles zone	Polygon	Not yet available
MSD1b	Coastline 6 miles zone	Polygon	Not yet available
MSD1c	Coastline 12 miles zone	Polygon	Not yet available
MSD1d	Coastline 50 miles zone	Polygon	Not yet available
MSD1e	Coastline 200 miles zone	Polygon	Not yet available
MSD2	Ports	Point	Not yet available
MSD3a	Depth Contours	Line	Not yet available
MSD3b	Temperature Regime	Line	Not yet available
MSD3c	Currents	Line	Not yet available
MSD3d	Salinity	Line	Not yet available
MSD4a	Habitats (Fish, Birds, Others)	Polygon/Point	Not yet available
MSD4b	Pressure Areas	Polygon/Point	Not yet available
MSD5a	Nutrients Input	Polygon/Point	Not yet available
MSD5b	Pollution Input	Polygon/Point	Not yet available

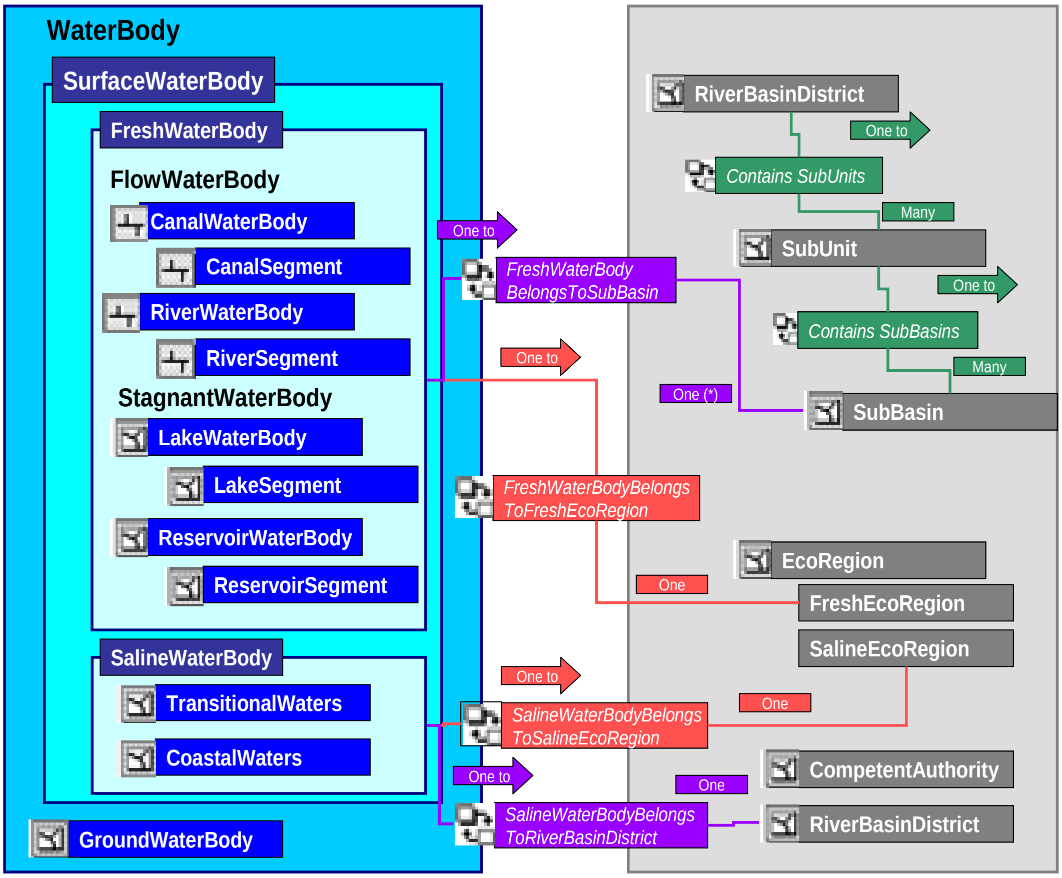
- **E-PRTR**

Layer Code	Layer Name	Feature Type	Availability in WISE

Layer Code	Layer Name	Feature Type	Availability in WISE
EPRTR1	Location of Sites	Point	EPER 2006

Detailed information on the GIS layers within each theme, including technical data specifications as defined by the INSPIRE Data Specification Methodology, is available in Appendix 05.

Under the WFD reporting requirements, several of GIS layers will have relationship to each other. Figure 5.2.1 shows the relationship between the WFD Articles 3 and 5 submitted data.



(*) A canal may belong to many subbasins, depending on how it was constructed

Figure 5.2.1 Relationship between features reported under WFD Articles 3 and 5

Further information on the data models associated with each of the themes is available in Chapter 5.3 and Appendix 06.

Data models and schemas are made available at the schema repository on the web site of the European Topic Centre on Water[43].

Short reporting guidelines are being developed for each obligation, see the template in Appendix 13.

[43] http://water.eionet.europa.eu/schemas/dir200060ec

5.3 Data Model

5.3.1 Purpose of the data model

Data models and data modeling are used in many parts of information system design and are also an important element of WISE development and documentation. Data models define the interaction between objects and their associated attribute information.

Data modeling is the first step in database and data exchange design: it is the blueprint from which the data structures and database will be built. By modeling, complexity is reduced in order to understand the essence of the data and its relationships.

Data models provide the basis of a common understanding of all of the features in a database, and how they can be used and accessed. Data models also aim to encourage consistency in data structures and so facilitate improved data sharing.

Data models describe how objects relate and link to other objects and also describe the attribute information associated with the objects. These descriptions are termed 'data dictionaries'.

The use of the modeling language UML (Unified Modelling Language) is recommended by the INSPIRE Directive[44]. UML as well as other modeling languages, in conjunction with data dictionaries, are used to describe the data models in WISE.

There are other conventions that describe the basic building blocks required for data modeling, namely:

- Structure diagrams that describe the inter-relationships between objects;
- Entity descriptions that describe the data object types and their attributes;
- Data dictionaries that provide detail about each attribute.

The use of other modeling conventions are therefore acceptable if the data modeling work has already been completed, in particular where schemas have been defined that can be used to automatically generate data dictionary definitions.

Data models and data dictionaries describe the inter-relationships of objects in each of the WISE datasets, or themes, and their associated attribute information. The data dictionary will include the following detail: field name, text description, field type and length, flag to indicate whether the field is mandatory or optional, any restrictions and enumeration or code lists (see Appendix 06).

5.3.2 INSPIRE – WISE models

The INSPIRE Directive requires that data structures used by multiple themes are modelled against a common conceptual model for a European Spatial Data Infrastructure, taking into account the following:

- Abstract types are used to model properties shared by objects across the different themes;

[44] http://inspire.jrc.ec.europa.eu/

- The conceptual model includes generic mechanisms to support simple integration or inter-linking of objects based on a common methodology for references to other features;
- A minimal base application schema is developed and types are moved to the base schema as become of general use.

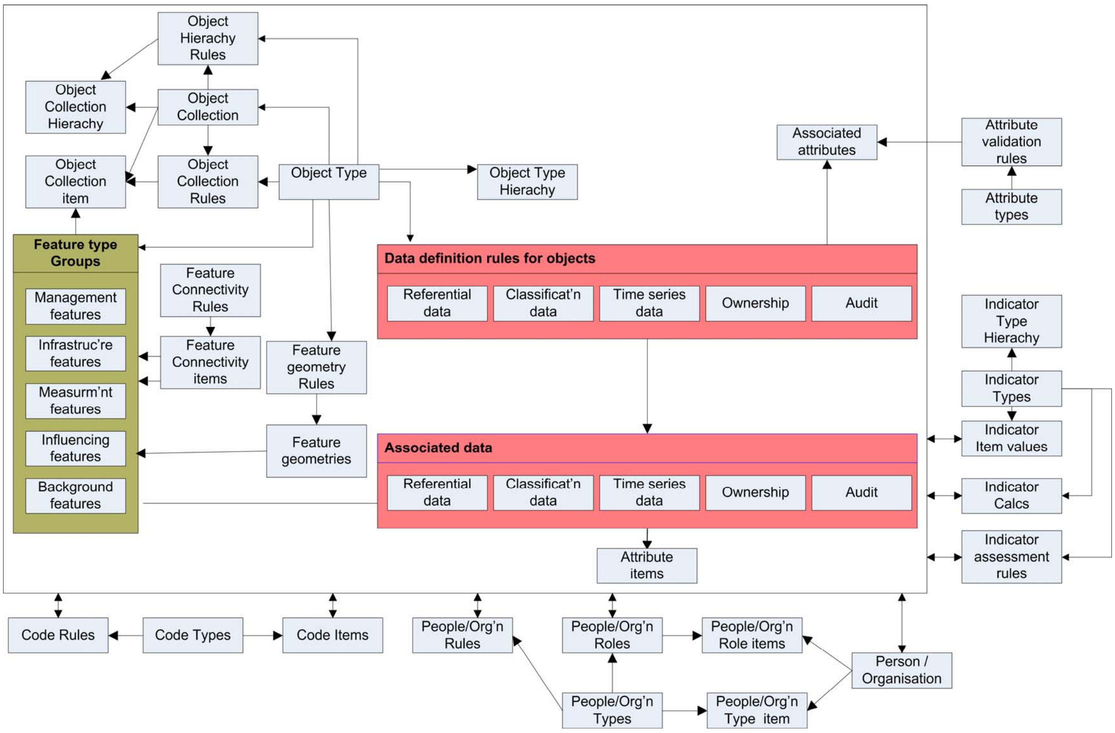


Figure 5.3.1 WISE conceptual model

The purpose of the WISE conceptual model is to identify commonality and to determine the building blocks that will enable integration and harmonisation. It is not the intention to create a single data model or database holding all data.

The WISE conceptual model is a meta-model and does not replace the data models associated with each theme within WISE, but allows the data for the themes to be put into the context of WISE, identifying inter-operability and harmonisation.

5.3.3 Description of the WISE conceptual model

Each geographic object (feature) falls into one of five group types:

- **Infrastructure features** - the basis of the water environment, e.g. rivers, lakes, groundwater, coastal waters, etc;
- **Management features** – the features used in sub-dividing the water environment into manageable units, e.g. River Basin Districts, water bodies and Sub-units;
- **Influencing features** – features that impact upon the water environment, e.g. Urban Waste Water Treatment Plants, Discharge Points, etc;
- **Measurement features** – where measurements are made on the above features, e.g. monitoring stations, gauging stations, sampling points, etc;

- **Background features** – features and objects that provide context to the above, e.g. cadastral maps, CCM, Corine Land Cover, etc.

Each feature has a specific feature type. Each feature type falls within a feature type hierarchy. For example, WaterBody can be sub-divided into SurfaceWaterBody and GroundwaterBody.

Each feature type has data associated with it. Data attributes are sub-divided into the following discrete types of data:

- **Referential data** - e.g. description, name;
- **Classification data** - e.g. typology;
- **Time series data** - e.g. value, unit of measurement, parameter, etc;
- **Ownership data** - e.g. responsible authority, External GIS dataset owner, etc;
- **Audit data** - e.g. date created, date last updated, etc.

Each of these types of data may be time-stamped as detail may change over time and the history may need to be retained.

Features can be grouped to form collections of objects, e.g. catchments, River Basin Districts, etc. Collection objects fall within a hierarchy, e.g. River Basin Districts contain Sub-units. Rules, based on feature type, determine which features can be grouped into collections of features. A collection object can also have attribute data associated with it, e.g. a River Basin District has associated referential, ownership and audit data.

Features also have a connectivity associated with them, e.g. monitoring station (measurement feature type) to river (infrastructure object), etc. Rules ensure that valid connectivity is defined. Connectivity rules will also be required for some collection features, e.g. catchment A flows into catchment B.

Calculation and assessment rules are identified to enable presentation and analysis.

Data standards are required to enable integration and ensure inter-operability. They apply to defined attributes and include the validation that should be applied, the rules needed to determine values, and the common codes that should be agreed and maintained so that common values can be shared across different datasets.

The WISE conceptual model recognises that there will be a need to maintain an agreed set of users and organisations. The data model identifies the need to determine ownership at various levels either through an organisation or a person within that organisation and to declare what role that user or organisation is undertaking.

5.3.4 Examples of the use of the WISE conceptual model

The various feature types can be grouped in accordance with their overall clasification.

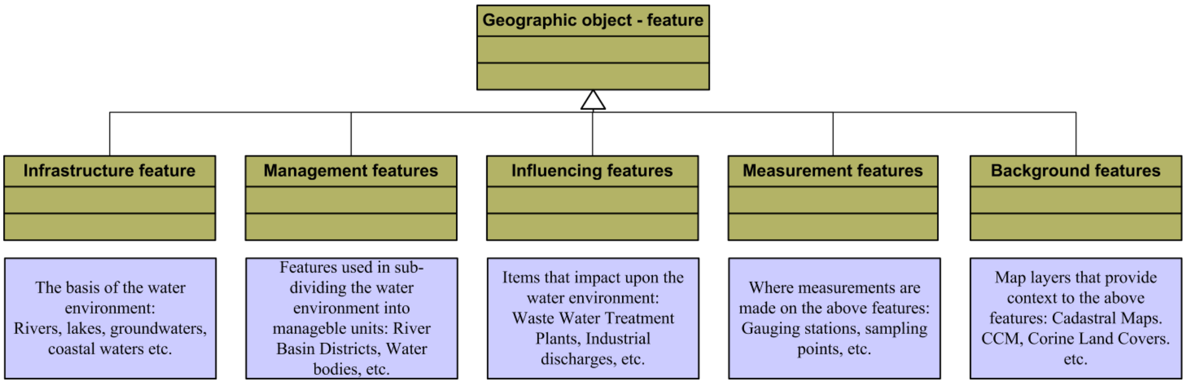


Figure 5.3.4a Groups of WISE feature types

Objects can be grouped into collections of objects, have sub-types and have attribute data. Relations between objects and feature types are also illustrated in the following diagram.

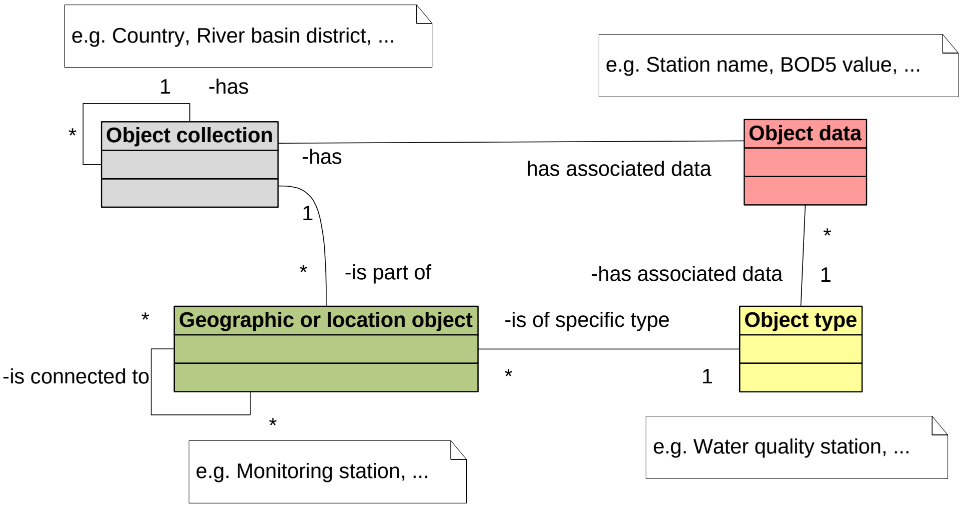


Figure 5.3.4b Example of relationships between objects and features

Objects can be part of hierarchies, as illustrated below.

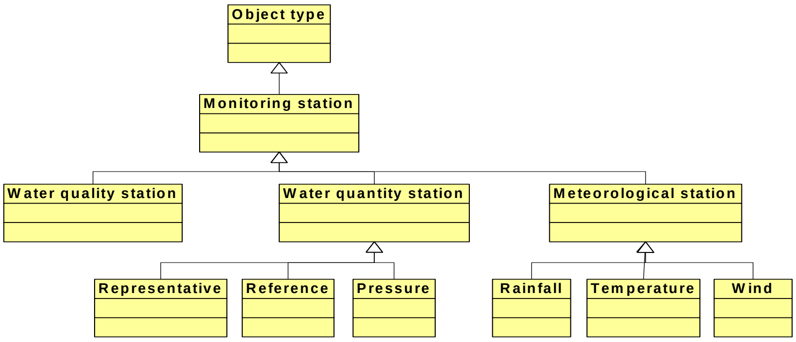


Figure 5.3.4c Object type hierarchies

Objects can have different types of data attributes associated with them.

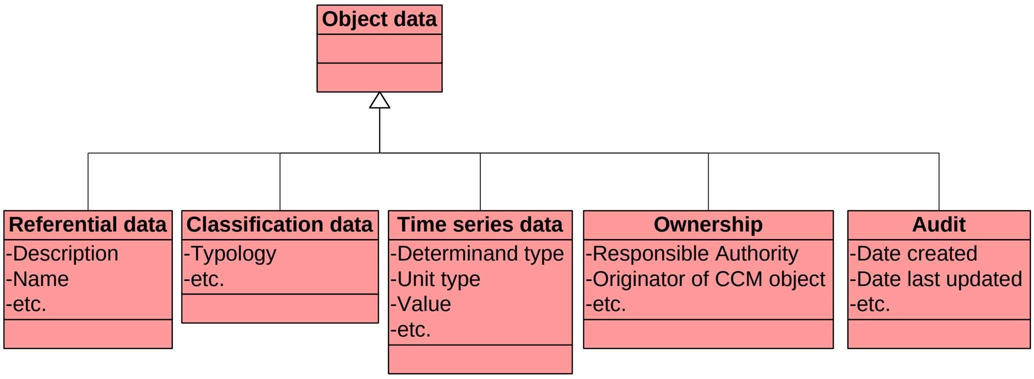


Figure 5.3.4d Types of attributes associated to objects

A transformation model can be used to describe data in terms of the WISE conceptual data model. This example refers to data relating to the Bathing Waters Directive.

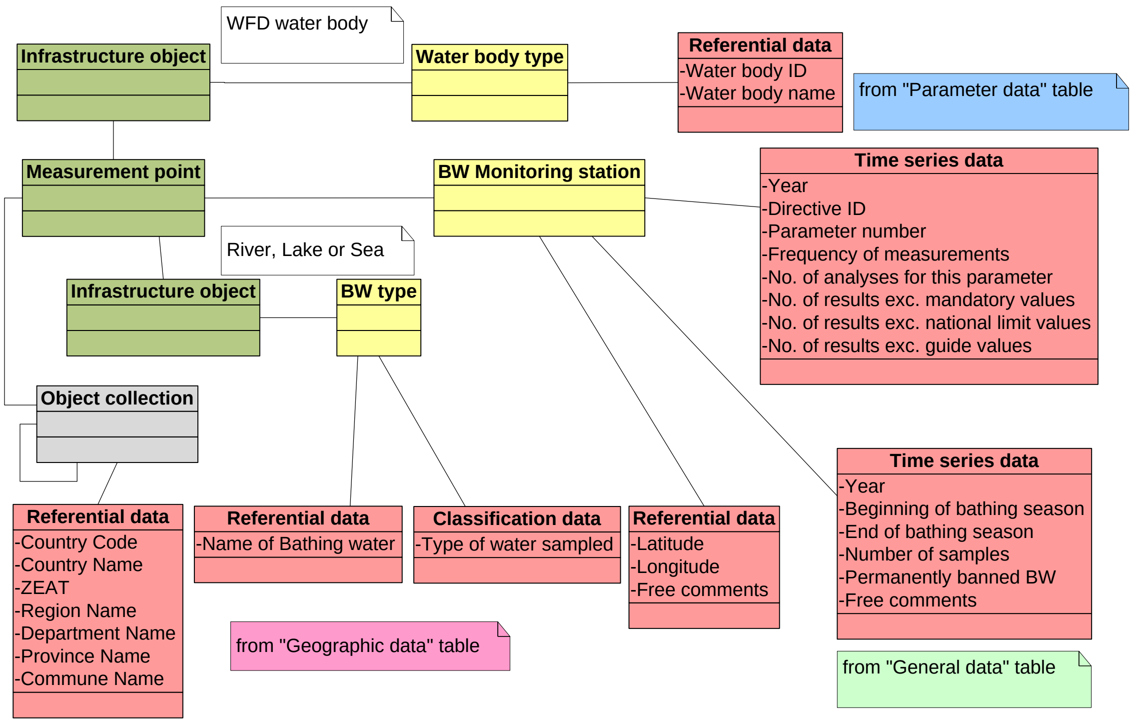


Figure 5.3.4e Transformation data model for the Bathing Water Directive theme

5.3.5 Data structure (class) diagrams

Within the WISE conceptual data model, data structure or class diagrams describe how logically related features are grouped together. For example, within the Water Framework Directive theme there are basic groups of features that have interactions: water bodies fall within River Basin Districts that in turn are managed by Competent Authorities.

These are represented by class diagrams within UML. The following data structure diagram describes conceptually a part of the Water Framework Directive data structures.

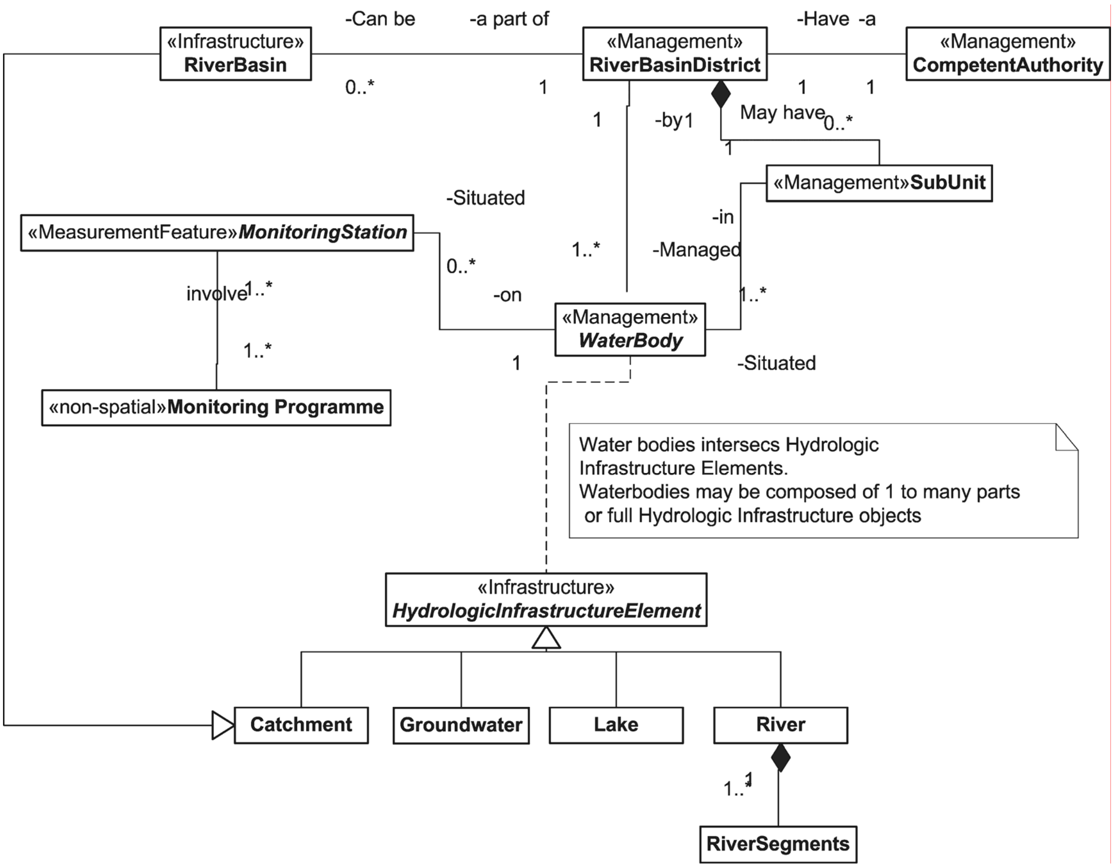


Figure 5.3.5 Part of the WISE conceptual data model relating to the Water Framework Directive

5.3.6 Feature classes

Feature classes group objects within the data model which contain explicit geometry. Feature classes are therefore either point, line or polygon features. All features in the feature class have geometry and a unique internal identifier in the database. Feature classes cannot mix geometry types: they must be exclusively points, lines or polygons.

Feature classes can be grouped and further sub-divided into nested hierarchies.

Example:

Feature

RiverBasinDistrict

Sub-unit

CompetentAuthority

RiverBasin

SubBasin

Feature *WaterBody*

- GroundwaterBody
- *SurfaceWaterBody*
  - *FreshWaterBody*
    - *Flow Water Body*
      - RiverWaterBody
        - RiverSegment
      - CanalWaterBody
        - CanalSegment
      - LakeWaterBody
        - LakeSegment
      - ReservoirWaterBody
        - ReservoirSegment
  - *SalineWaterBody*
    - TransitionalWaters
    - CoastalWaters

Feature

- EcoRegion

Feature

- *ProtectedArea*
  - HabitatsProtection
  - BirdsProtection
  - NutrientSensitiveArea
  - NitratesVulnerableArea
  - EconomicSpeciesProtection
  - Drinking water protection
  - RecreationalWater

Feature classes named in italics are abstract types never being realized. Inheritance allows classes to be related to parents through generalisation. The more specific class inherits attributes from the more general class. The Figure 5.3.6 show a small extract of the WISE logical data model, inheritance is in UML shown with a hollow triangle.

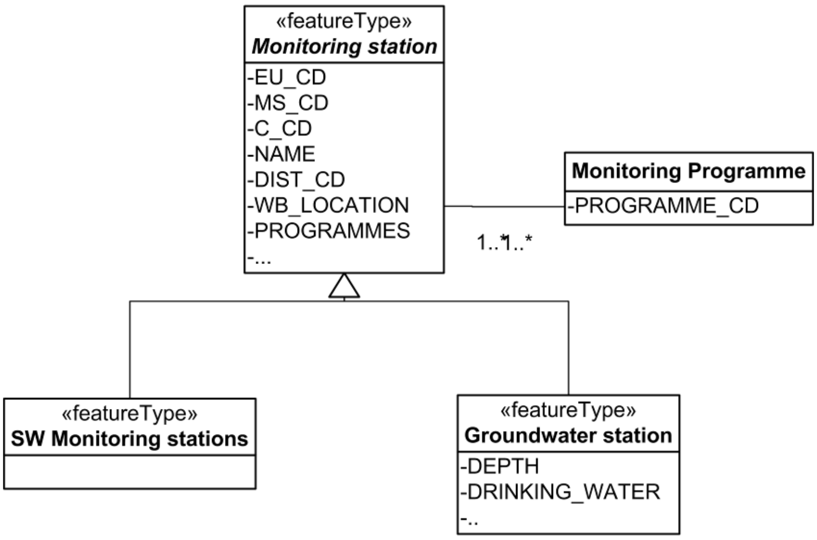


Figure 5.3.6 An extract of WISE logical data model

5.3.7 Object descriptions

In practical terms, every UML feature class becomes a table. Every UML feature class has attributes associated with it.

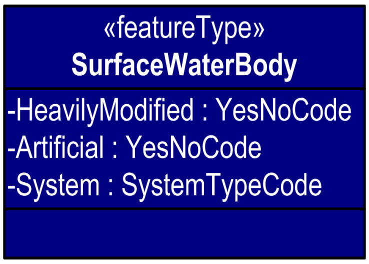
Two examples of object descriptions are shown below:

WaterBody

The WaterBody feature class defines the following attributes:

- **EuropeanCode** – a unique identifier at the European level (cf WG Coding Systems), including the 2 character ISO 3166 country code;
- **Name;**
- **MSCode** - the unique code for the water body defined by the Member State;
- **EcoRegionCode** - the relationship between a water body and its parent EcoRegion is via the EcoRegionCode;
- **InsertedWhen;**
- **InsertedBy;**
- **RiverBasinCode** - the relationship between a water body and its parent River Basin District is via the RiverBasinCode;
- **StatusYear.**

SurfaceWaterBody



All SurfaceWaterBody feature classes inherit from the WaterBody feature class. A SurfaceWaterBody feature class defines attributes which are associated specifically with the SurfaceWaterBody feature class:

- **HeavilyModified** - True/False;
- **Artificial** - True/False;
- **System** - whether the water body is Type A or Type B.

Each attribute in a class becomes a field in a database table. Data dictionaries contain further detail about the attributes. The domains shown refer to the common data types defined in the XML schema WFDCommon.xsd.

5.3.8 Data dictionary

All the attributes that are associated with each GIS layer and dataset, or theme, in WISE are detailed in data dictionaries. The following information is provided for each attribute:

- Its given name;
- Its data type;
- Its data length;
- Any associated codes;
- Any associated constraints.

The following is an example of a data dictionary entry:

EcoRegion

Attribute	FieldName	Definition	Type	Length	Restrictions
Shape	SHAPE	Geometry (polygons)	Geometry		
Name	NAME	Locally used name	String	40	
EcoRegionCode	REGION_CD	Codes as specified by Annex XI	String	2	{1-25} {AT = Atlantic, NO = Norwegian, BR = Barents, NT = North Sea, BA = Baltic, ME = Mediterranean}

Figure 5.3.8 Example of an entry in a data dictionary

More details of a data dictionary can be found in Appendix 06.

The Eionet-Water data dictionary is an example of an on-line data dictionary: http://dd.eionet.europa.eu/. Direction to the proper part of the data dictionary may also be obtained from the relevant reporting obligation from the (on-line) Reporting Obligations Database: http://rod.eionet.europa.eu/.

5.4 European Feature Coding

5.4.1 Introduction

GIS feature coding is the assignment of unique identifiers or codes to each spatial object that will be referenced by GIS. This assignment needs to be managed to ensure uniqueness at national and international levels. Standard identifier formats will ease electronic data transfer and enhance the possibility of central querying against distributed storage.

The common framework for the unique identification of spatial objects and the concept for ID management in WISE are described in Chapter 4.4. It deals with specific aspects of identifier management as regards reporting of spatial data by Member States and the development of WISE reference GIS datasets.

The spatial feature available in WISE can be classified into **Non-hydrological features** and **Hydrological features:**

- **Non-hydrological features** should be assigned with a **non-hydrological unique object identifier** but should carry the code of the **hydrological feature** to which they are related as foreign key;
- **Hydrological features** should carry a unique **hydrological feature code**.

This Chapter provides details of the structure of the non-hydrological unique object identifier and the hydrological feature code.

5.4.2 Non-hydrological unique identifiers

The structure of the non-hydrological unique identifiers will be as follows:

- A namespace to identify the data source. The namespace is owned by the data provider;
- A local identifier, assigned by the data provider. The local identifier should be unique within the namespace.

5.4.2.1 Member States submitted GIS data

If the data provider is a Member State, the namespace shall be the two letter ISO 3166 code of the Member State. The local identifier can be 22 characters long at maximum. Thus, the unique non-hydrological identifier provided by Member States should have the following structure:

MS$\#_1\#_2\ldots\#_{22}$ where:

MS . = a 2 character Member State identifier, in accordance with ISO 3166-1-Alpha-2 country codes; and

$\#_1\#_2\ldots\#_{22}$ = an up to 22 character feature identifier that is unique within the Member State.

(symbol # = wildcard character (a wildcard character can be used to substitute for any other character or characters in a string)).

The maximum total length of the identifier therefore will be 24 characters.

Example:

a *Groundwater Body in Germany* might have the identifier DE45734

or a *Lake Monitoring Station in Spain* might have the identifier ES67003800958730

Special advice given is that:

- The local identifier shall only use the following set of characters: {“A”…”Z”, “a”…”z”, “0”…”9”, “_”, “.”, “-“, “,”}, i.e. only letters from the Latin alphabet, digits, underscore, point, comma, and dash are allowed;
- Alphabetical characters should always be in upper case;
- Special characters must be avoided, such as ‘$’, ‘!’, ‘&’, ‘ë’, ‘á’, etc;
- Digits should be used where practical to help avoid the above problems.

Entity types can be used to identify the type of a feature. The entity type code segment is fixed to two characters. An example is given below. The list can be extended as needed, but has to be managed at the European level in order to prevent creating ambiguous codes.

- Non-hydrological features (examples);

Entity type	Code
o Monitoring station	MO
o River Basin District	BD
o …	

- Specifications for reporting geographical data under UWWTD (examples)

Entity type	Code
o Sensitive Area	SA
o Sensitive Area – river	RI
o Sensitive Area – lake	LK
o …	

5.4.2.2 WISE Reference GIS datasets

So far the WISE Reference GIS datasets: **Large Rivers and Large Lakes** and **River Basin Districts** have been developed. The datasets are available in the WISE map viewer (See Chapter 3.2 for an illustration of the River Basin Districts WISE Reference GIS dataset). The identifiers of the River Basin Districts (identifying the

RBD irrespective of country borders) and the Member State parts of RBDs can be seen at:
http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=1041.

5.4.3 European coding system for hydrological features

If rivers are already substantially identified, it may be pragmatic to extend the existing approach to uniquely identify objects. However, the number of rivers to be identified may amount to many times the number already coded. Codes may also need to be reviewed to achieve harmonisation with Member States involved in shared RBDs. Coding could be as simple as sequential identifiers; however, structured hydrological codes are recommended. This enables rapid manual or automated analyses without the need to refer to GIS. This includes tracing facilities including rivers, catchments and associated objects (upstream/downstream identification). Furthermore connectivity between rivers across boundaries has to be created and thus data analysis within international RBDs will be facilitated. Hierarchical structured coding also tends to ease long-term unique code maintenance.

A modified version of the Pfafstetter system is proposed as the European coding system for hydrological features. The hydrological code is composed of different segments, which together uniquely identify a hydrological feature. The hydrological code consists of 6 hierarchical related items. The first item is a character defining the Ocean or Endorheic system. It is followed by one digit numbering of the seas into which the Ocean can be subdivided. In the case of islands subsequently a sequence number of the island order along the coast is defined. The landmasses thus defined can be subdivided at sea outlet level using the 5 digit length commencement code. Finally the river system can be coded up to the river reach level using the Pfafstetter methodology. Furthermore an entity type code segment will define the type of feature that is referenced by the code. These are e.g. river segments, lakes and basins.

Table 5.4.3a Elements of the Hydrological Coding

Abbreviation	**Logical Element**	**Relation to**	**Data type**	**Min., Max. Length**
H or HDM_ID	Coastline, Hydrological system		String	1
S or SEA_ID	Coastline, Sea	Hydrological system	Number 1-9,	1
II or Island sort	Landmass, Island sort	Sea and Hydrological system	Hexadecimal number	2
CCCCC or Commencement	Sea outlet commencement code	Sea and Hydrological system and Island	Number 11111 – 99999,	5
P or Pfafstetter	River segments, lakes, river basins Pfafstetter	Seaoutlet	Number	1-12
E or Entity type	Entity type code		Character	2

L or Lake identifier	Lake identifier		Character	0,2

In a database typically these codes are to be stored in separate files, allowing a programmer to use the various data elements in a flexible manner. For data exchange functions it is useful to concatenate the elements, thus simplifying the exchange procedures and the eventual need to type in the code by a user.

The format of the code will be as follows:

HSIICCCCCPPPPPPPPPPPPPEELL

Hydrological system and Sea region code (**HS**IICCCCCPPPPPPPPPPPPPEELL)

The identification of the sea region constitutes the first segment of the whole code. The hydrological coding system reveals into which sea the various European watersheds are flowing and how those seas are connected to the ocean, the ordering of data can be enhanced. A limited hierarchical model is used in order to make these connections explicit in the coding system for the oceans and seas.

The coding of the sea region would be mandatory for all hydrologic reference features. It is proposed to define a unique identifier of one letter to mark the various Hydrological Systems or oceans that can be distinguished. The seas that are part of these oceans can subsequently be marked with one number. If the number is higher (9) than the distance of the sea to the ocean it exchanges water with is longer, in accordance with the Pfafstetter coding in which digit 9 marks the longest flow path and 1 the outlet of a river system into the sea. Thus the length of the code segment would be two characters, a letter for the Hydrological System or ocean and a number for the seas.

We propose to distinguish seven Oceans: Arctic Ocean, Northern Atlantic Ocean, Southern Atlantic Ocean, the Indian Ocean, the Pacific Ocean and the Mediterranean Sea. In the coding system these oceans all receive one letter as proposed in Table 5.4.3b.

Table 5.4.3b Definition of an Ocean letter to identify into which hydrographic system water from a surface water body eventually flows into.

Code	**Oceans**
A	Northern Atlantic Ocean
M	Mediterranean Sea
N	Arctic Ocean
S	Southern Atlantic Ocean
I	Indian Ocean
P	Northern Pacific Ocean
B	Southern Pacific Ocean

For endorheic systems relevant for Europe, including Turkey and the Caucasus, the codes proposed can be found in Table 5.4.3c.

Table 5.4.3c Definition of endorheic systems with surface water flow in Europe including Turkey and the Caucasus

Code	Endorheic System
C	Caspian Sea
H	Orumiyeh Lake
V	Van Lake
Z	Tuz Saltlake

There are two more endorheic systems, Prespa Lake and Trasimeno Lake. These systems are quite small and for the purpose of the WISE, they are integrated into the surrounding drainage area.

Most of the thus defined hydrographic systems can be subdivided by subsystems such as seas, bays or straits. For the use of grouping data within European policies we only propose here a subdivision of the Northern Atlantic Ocean East coasts. In order to code the seas relevant to the European Subcontinent it is proposed to distinguish the following seas (Table 5.4.3d):

Table 5.4.3d Numeric code of the Seas around Europe

Hydrographical System	Sea number	Sea Name
North Eastern Atlantic	1	Open Ocean
	2	Norwegian Sea
	4	Celtic Sea and Channels
	5	North Sea
	6	Baltic Sea
Mediterranean Sea	2	North Western Basin
	4	North Eastern Basin
	5	Black Sea
Arctic Ocean	7	Barents Sea East
	8	White Sea
	9	Barents Sea West
Caspian Sea	1	No subdivision
Indian Ocean	1	Persian Gulf

Island coding (HS**II**CCCCCPPPPPPPPPPPPEELL)

A proposal to code islands can be found in Appendix 08. The islands can be identified by the code of the sea they lie within, followed by a sequence number. The sequence number is generated by selecting the closest continental coast line segments ordering number. It is proposed to relate the sequence number to the coastal segment at the shortest distance to the island. In some cases many islands are to be connected to the same coastal segment. In such cases the final sequence number can be generated by using the shortest distance to the coastal segment.

Pfafstetter commencement code (HSII**CCCCC**PPPPPPPPPPPPEELL)

The second code segment would identify the primary catchment or a coastal catchment within the respective sea region. The commencement code will be defined at the European level based on the basins and sub-basins of the national datasets that have been reported according to Article 3 of WFD. The determination of the code should follow the same logic as the Pfafstetter code. The four largest sea outlets (river basins) within each sea region should be assigned with the figures 2, 4, 6 and 8 in clockwise rotation. The coastal region between these sea outlets (river basins) should be assigned with odd numbers 1,3,5,7 and 9 (see Figure 5.4.1).

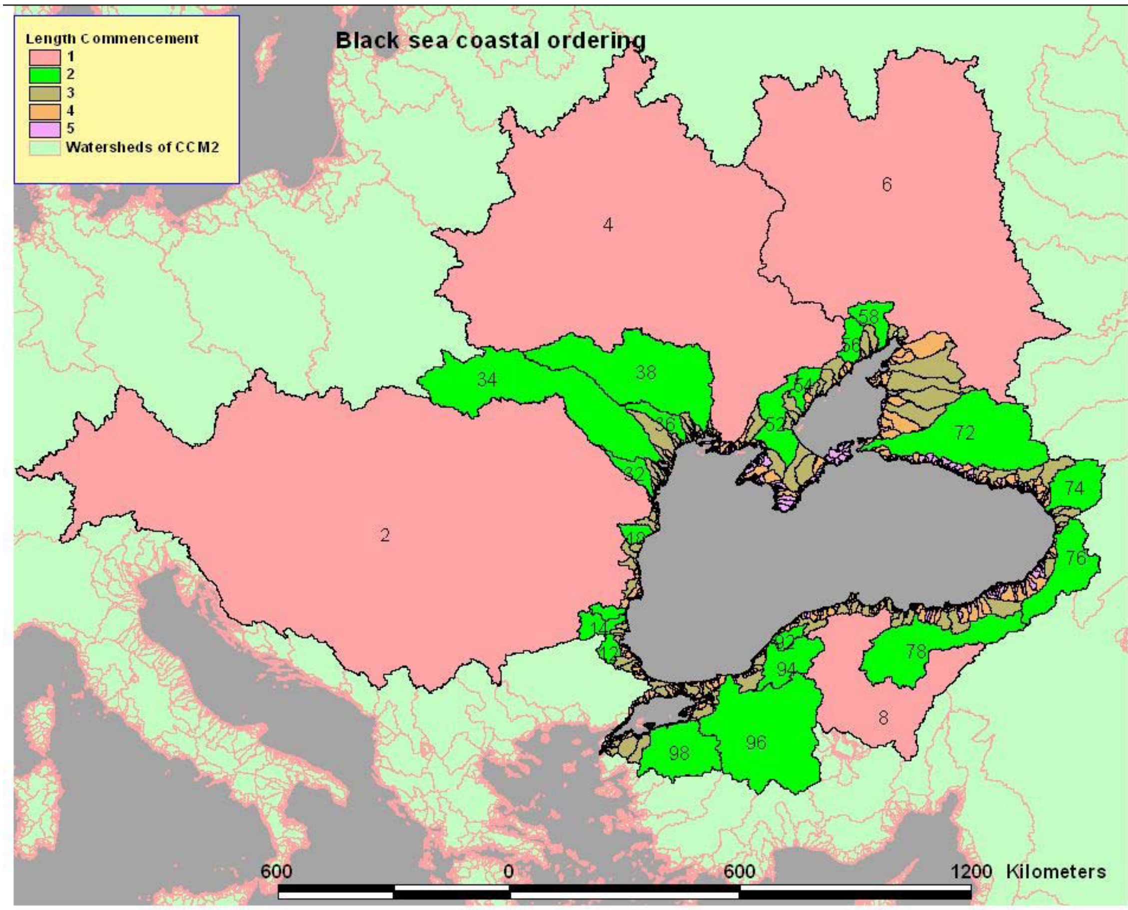


Figure 5.4.1: Commencement code for the Black Sea related Seaoutlets. The length of the code yields an indication of size

This commencement code has already been defined for CCM2 and the data can be downloaded at http://desert.jrc.ec.europa.eu/water/ccm/php/index.php.

River segments, lakes and river basins (HSIICCCCC**PPPPPPPPPPPP**EELL)

The Pfafstetter approach is recommended for providing a structured hydrological code segment, identifying river basins and river sub basins. Codes identified for river basins and sub-basins can be assigned to the associated river segments. The Pfafstetter system follows a systematic approach as it is derived from topological relationships of the underlying drainage system. The numbering schema is self-replicating from the largest to the smallest drainage system. With Pfafstetter codes it is possible to identify all nested sub-basins within the larger basin and the "parent" basin from a sub-basin. All upstream sub-basins or river segments as well as all downstream segments are identifiable at each location of the river network. More details of the creation of the code can be found in Appendices 07 and 08. (The principles of the system are explained in Appendix 07. Appendix 08 gives more details about the application of the system, taking also the island coding into consideration and the extension of the ocean and sea region coding as explained in this Chapter).

Lakes should be included in the Pfafstetter coding system. If they are connected to the river network, they should receive the Pfafstetter code of the river segment to which they drain (the outlet). If they are not connected to the river network, they should receive the code of the lowest level river (sub-) basin or interbasin in which they are located. In case that more than one isolated lake is located within one sub- or interbasin, lakes should be distinguished by a specific identifier. This specific identifier should be appended after the entity code to be able to code international lakes. A maximum of 2 characters are reserved for this segment. The code segment should only contain digits. Examples of lake coding are illustrated in Appendix 07.

For the implementation of a Pfafstetter system, the river network must be fully connected also within the lakes. These hypothetical river segments are sometimes called continua. As a consequence, water bodies within a lake can be identified according to the codes of the underlying river segments, if required.

Entity type (HSIICCCCCPPPPPPPPPPPPP**EE**LL)

As described with the coding system for non-hydrological reference features, an entity type code can be used to identify types of hydrological features. A list of possible entity type codes is given in Appendix 07. Examples are given below. The list can be extended as needed, but has to be managed at the European level in order to prevent ambiguous codes being created.

- Hydrological features (examples)

Entity type	**Code**
o River basin	BA
o River segment	RS
o …	

Conditional lake identifier (HSIICCCCCPPPPPPPPPPPPPEE**LL**)

An additional unique string is required for identifying lakes that are not connected to a river network. The identifier is necessary if there is more than one lake within a specific river basin. International lakes should be identified with one code (identifying the total lake and not only national parts of the lake). As a consequence, the identifier has to be managed within an international river basin on the European or international level.

It is proposed to reserve a maximum of two characters for this code segment. The code could consist of numbers and characters.

Other identifiers

The coding of special cases such as bifurcations, karst phenomena and canals is described in Appendix 07.

5.4.4 Application of the European coding system for hydrological features

The application of the code to hydrological features requires a topologically correct and connected river network including lakes and a dataset of basins with the catchment boundaries. There has to be a spatial relationship between the basins dataset and the river network as the order of Pfafstetter code assignment is determined by the size of the catchments. International basins, rivers and lakes have to be consistent across national boundaries.

The European coding system for hydrological features will be applied at EU level to the WISE Reference GIS datasets of main rivers (including river segment coding and river codes) and main lakes. The coding system is being tested in the Danube River Basin District at rivers with a catchment > 1000 km². The methodology and results will be available as Appendix 09 from March 2009.

5.4.4.1 Application of the coding system at EU level - Hydrological Reference Features

The European coding system for hydrological features will be applied at the European level to hydrological reference features used in harmonised European reference datasets (WISE Reference GIS datasets). These will be the Main Rivers and Main Lakes and, in future, the correlated river basins, sub-basins and catchments. The codes will be defined using the European dataset of catchment areas and derived rivers (CCM2). The generated codes will then be transferred from CCM2 to the submitted national datasets which form the reference datasets of Main Rivers and Main Lakes. The datasets will be created at the European level and provided to Member States.

Each river segment of the European reference dataset Main Rivers will carry the European hydrological feature code for river segments, the European river code and the RBD code. Each lake of the European main lakes dataset will carry the European hydrological feature code of the lake and the European RBD code.

5.4.4.2 Application of the coding system at Member State level (rivers, lakes)

Member States are not requested to apply the proposed European coding system for hydrological features to their national hydrological features as they probably have a national hydrological coding system already in place. However, Member States are invited to apply the European coding system for hydrological features at the national level. The Pfafstetter commencement code can be obtained from the CCM2 dataset.[45]

To allow the linkage of national hydrological features to European hydrological reference features, it is recommended that Member States add the following as attributes to their national hydrological river and lake datasets:

- European river code of the WISE Reference GIS dataset main rivers;
- European lake code of the WISE Reference GIS dataset main lakes;

[45] http://desert.jrc.ec.europa.eu/action/php/index.php?action=view&id=23

- European Pfafstetter codes of transboundary rivers segments (including border river segments) and transboundary lakes.

Of particular importance are transboundary features, border rivers and border lakes. It is proposed to harmonise these features respectively at national and international River Basin District levels (see Chapter 6.1). As long as these features are not harmonised, harmonisation will take place at EU level (see Chapter 3.1) and the dataset and the corresponding codes will be provided to Member States. As soon as national/international harmonised features are available they will substitute features harmonised at EU level.

5.5 Metadata

5.5.1 What are metadata?

Metadata are information that describe the content, quality, condition, origin and other characteristics of data or other pieces of information related to the data. Metadata are important since they make data understandable and they make it easier for data to be shared. As we are witnessing a rapid increase in the availability of digital data, the need for effective metadata increases so that users can properly discover and evaluate relevant data resources.

5.5.2 Structured and unstructured metadata

Although in many cases metadata can be inferred from data resources, a structured approach to collecting and publishing metadata is beneficial since it increases consistency. The advent of sophisticated Internet-based indexing and search engines and tools have gone a long way to help locate digital information resources, but basic problems remain in that categorisation and cataloguing of resources remains limited.

5.5.3 Metadata standardisation

5.5.3.1 International Standards Organisation (ISO)

In the domain of geographic information a number of standardisation activities have taken place which provide a formal basis for describing geographic data and services.

In 2003 the International Standards Organisation (ISO) adopted the standard ISO19115:2003 Geographic Information – Metadata.

In 2005 this was followed by the adoption of ISO19119:2005 Geographic Information – Services.

With the adoption of ISO19139:2007 Geographic Information – Metadata – XML Schema Implementation, developers now have access to a comprehensive metadata implementation specification.

The ISO standards are over-arching. ISO19115 has approximately 300 elements, an exhaustive list, but of course many of these are redundant for certain applications. As a consequence, many communities have developed profiles, an agreed sub-set of elements.

5.5.3.2 Other standardisation initiatives

The development of the US FGDC Metadata format (CSDGM) preceded ISO19115, and has been widely adopted outside the US. CSDGM is now being aligned to ISO19115. The other widely used metadata standard is the DCMI (Dublin Core Metadata Initiative).

5.5.4 INSPIRE and WISE metadata profiles

The elements required for describing geographic data and services falling under the scope of INSPIRE are detailed in the INSPIRE Directive[46].

The INSPIRE metadata elements have been selected to support the primary function of discovery. For 10 categories, there are a total of 27 metadata elements.

It is important to note that whilst in general INSPIRE advocates the use of recognised standards it is not a requirement to fulfil the obligations of the INSPIRE metadata regulation to adopt ISO19115 or related standards for implementation. However, in practical terms, many organisations will choose to adopt such an approach, and non-binding guidelines have been published, see: http://inspire.jrc.it/reports/ImplementingRules/metadata/Draft_Guidelines%20_INSPIRE_metadata_implementing_rules.pdf which "map" INSPIRE metadata elements to their corresponding ISO elements.

The WISE metadata profile should support the functions of discovery and usage. The original WFD GIS Guidance Document (Vogt 2002) defined a metadata profile based on the draft version of ISO19115 that existed at the time, and further work was undertaken with the SDIGER-project.

Since the majority of WISE datasets and services will fall under the scope of INSPIRE, this guidance recommends the adoption of a profile which extends the INSPIRE metadata to include all those additional elements already agreed by the WISE community.

This guidance recommends the use of INSPIRE terminology for element names wherever possible, thus ensuring compatibility with metadata created in other environmental policy areas.

An overview of the WISE metadata profile is provided below with a more elaborated version found in Appendix 10. Details of implementation of the metadata elements are provided in Appendix 11.

Table 5.5.4 Overview of the WISE metadata profile

Category	Element Name	Description	Condition	Value Domain	Multiplicity
IDENTIFICATION	1.1 Resource title	This is a characteristic, and often-unique, name by which the resource is known.	Mandatory	Free text	1
	1.2 Resource abstract	This is a brief narrative summary of the content of the resource	Mandatory	Free text	1
	1.3 Resource type	This is the type of	Mandatory	Part D.1. of the	1

46 http://inspire.jrc.ec.europa.eu/

Category	Element Name	Description	Condition	Value Domain	Multiplicity
		resource described by the metadata		MD IR	
	1.4 Resource locator	The resource locator defines the link(s) to the resource and/or the link to additional information about the resource	Mandatory if a URL is available to obtain more information on the resource, and/or access related services	Character string expressed by a URL	0..*
	1.5 Unique resource identifier	A value uniquely identifying the resource	Mandatory	Character string + character string namespace	1..*
	1.6 Coupled resource	*Identification of the target spatial data set(s) of the services trough their Unique Resources Identifiers (URI)*	*Mandatory if linkage to the service is available*	*Character string code + character string namespace*	*0..**
	1.7 Resource language	The language(s) used within the resource	Mandatory if the resource includes textual information	ISO 639-2	0..*
CLASSIFICATION OF SPATIAL DATA SETS & SERVICES	2.1 Topic category	High-level classification scheme	Mandatory	Part D.2 of the MD IR	1..*
	2.2 Spatial data service type	*This is a classification to assist in the search of available spatial data services*	*Mandatory*	*Part D.3 of the MD IR*	*1*
KEYWORD	3.1 Keyword value	A commonly used word, formalized word or phrase used to describe the subject	Spatial data set or spatial data set series: at least one keyword from GEMET	Free text	1..*
			Spatial data service: at least one keyword from Part D.4 of the MD IR	*Part D.4 of the MD IR*	*1..**
	3.2 Originating controlled vocabulary	The citation of the originating controlled vocabulary shall include at least its title and a reference date (publication, last revision or creation)	Mandatory if the keyword originates from a Controlled vocabulary	Free text + date	1..*
GEOGRAPHIC LOCATION	4.1 Geographic bounding box	Extent of the resource in the geographic space	Spatial data set or spatial data set series: Mandatory	Decimal degrees with at least two decimals	1..*
			Spatial data service: Mandatory for services with an explicit geographic extent	*Decimal degrees with at least two decimals*	*0..**
TEMPORAL REFERENCE	5.1 Temporal extent	Time period covered by the resource as an individual date, an interval of dates or a mix of both	At least one of the metadata elements referred to points 5.1 to 5.4	ISO 8601	1..*
	5.2 Date of	Date of publication or	At least one of	ISO 8601	1..*

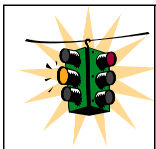
Category	Element Name	Description	Condition	Value Domain	Multiplicity
	publication	entry into force of the resource	the metadata elements referred to points 5.1 to 5.4		
	5.3 Date of last revision	Date of last revision of the resource	At least one of the metadata elements referred to points 5.1 to 5.4	ISO 8601	1
	5.4 Date of creation	Date of creation of the resource	At least one of the metadata elements referred to points 5.1 to 5.4	ISO 8601	1
QUALITY & VALIDITY	6.1 Lineage	Statement on process history and/or overall quality of the spatial data set	Mandatory	Free text	1
	6.2 Spatial resolution	Level of detail of the dataset: it shall be expressed as a set of zero to many resolution distances or equivalent scales	Mandatory	Equivalent scale expressed as an integer; resolution distance expressed as a numerical value	0..*
CONFORMITY	7.1 Specification	Citation of the implementing rules adopted under Article 7(1) of Directive 2007/2/EC or other specification to which a particular resource conforms	Mandatory	Free text + date	1..*
	7.2 Degree	Degree of conformity of the resource to the implementing rules adopted under Article 7(1) of Directive 2007/2/EC or other specification	Mandatory	Part D.5 of the MD IR	1
CONSTRAINT RELATED TO ACCESS & USE	8.1 Conditions applying to access and use	Conditions for access and use of spatial data sets and services, and where applicable, corresponding fees	Mandatory	Free text + URL if applicable for information on any fees	1..*
	8.2 Limitations on public access	Limitations on public access and the reasons for them	Mandatory	Free text	1..*
ORGANISATIONS RESPONSIBLE FOR THE ESTABLISHMENT, MANAGEMENT, MAINTENANCE AND DISTRIBUTION OF SPATIAL DATA SETS AND SERVICES	9.1 Responsible party	Description of the organisation responsible for the establishment, management, maintenance and distribution of the resource	Mandatory	Free text + e-mail address as a character string	1..*
	9.2 Responsible party role	Role of the responsible organisation	Mandatory	Part D.6 of the MD IR	
METADATA ON METADATA	10.1 Metadata point of contact	Description of the organisation responsible for the creation and maintenance of the metadata	Mandatory	Free text + e-mail address as a character string	1..*
	10.2 Metadata date	Date the metadata	Mandatory	ISO 8601	1

Category	Element Name	Description	Condition	Value Domain	Multiplicity
		record was created or updated			
	10.3 Metadata language	Language in which the metadata are expressed	Mandatory	ISO 639-2	1
WISE METADATA	11.1 Distribution format	Provides a description of the format of the data to be distributed	Mandatory	Free text	1..*
	11.2 Metadata standard name	Name of the metadata standard (including profile name) used	Mandatory	Free text	1
	11.3 Metadata standard version	Version (profile) of the metadatastandard used	Mandatory	Free text	1
	11.4 Metadata file identifier	Unique identifier for this metadata file	Optional	Free text	0..1
	11.5 Metadata character set	Full name of the character coding standard used for the dataset	Optional	MD_CharacterSet Code <<CodeList>> (B.5.10)	0..1
	11.6 Reference system	Description of the spatial and temporal reference systems used in the dataset	Optional	MD_ReferenceSys tem (B.2.7)	0..*
	11.7 Spatial representation type	Method used to spatially represent geographic information	Conditional: if the resource is a dataset or dataset series	MD_SpatialRepres entationTypeCode	0..*
	11.8 Credit	Recognition of those who contributed to the resource(s)	Optional	Free text	0..*
	11.9 Presentation form	Mode in which the resource is represented	Optional	CI_PresentationFo rmCode	0..*
	11.10 Purpose	Summary of the intentions with which the resource(s) was developed	Optional	Free text	0..*
	11.11 Specific usage	Brief description of the resource and/or resource series usage	Optional	Free text	0..*
	11.12 Vertical extent	Provides vertical component of the extent of the referring object	Optional	EX_VerticalExtent	0..*

Note: Metadata elements marked in italics are only relevant for metadata covering services.

5.5.5 Which WISE components require metadata?

Metadata should be created with all geographical information being reported to, developed in the context of, or disseminated through WISE. A sub-set of the metadata elements found in the WISE profile for spatial data would also be applicable for non-spatial data submitted by Member States.



Look out!

Mandatory delivery of metadata may develop further

The application of mandatory metadata using specific elements from the profile may be extended to reporting outside the scope of GIS data.

5.5.6 Metadata creation methods

The authoring and editing of metadata in WISE can be done in a number of ways including:

- The use of a dedicated WISE metadata web-based entry page, with basic client-side validation. At the present time this does not exist, but could be developed in the future;
- The use of a metadata editor, capable of outputting metadata according to the recognised WISE metadata XML schema. This can be direct (i.e. if the tool can be configured to export according to this schema), or indirect (i.e. using XSL transformations to map from the native XML schema of the specific tool to the WISE XML schema).

There are many tools which allow metadata editing and which are based on the ISO standards.

5.5.7 WISE XML Schema

An XML schema for the WISE metadata will be available from the WISE portal.

5.6 Standards for data exchange

5.6.1 Purpose for standards in data exchange

In addition to the optimisation of data collection and the reuse of data, one of the major goals of WISE is to streamline the data exchange between the Member States and the European Commission (EC).

The way data is collected and stored, its quality and coverage will vary from organisation to organisation responsible for the managing and reporting of data. Each organisation will have to implement procedures and modules that facilitate the data exchange processes according to formats agreed between the data provider and the data user.

The development of common standards serving the WISE community has a number of benefits:

- The users may reduce the cost for development and implementation of a specific reporting flow;
- The development of the reporting specifications will be easier and may reuse previously developed components;
- Given that GML is recommended, the developed application and data structure schemas may provide a basis for both file exchange and web service development.

In 2004, the WFD guidance document no. 9 Implementing the Geographical Information System Elements (GIS) of the Water Framework Directive[47] identified a short term approach and a long term approach.

The short term approach pointed to the use of Geography Markup Language (GML) as best practise and the published open standard file format ESRI shape file[48] as a minimum standard. The long term approach (for 2009) recommends the use of web services, which is covered in more detail in Chapter 5.7.

The recommendation of GML has recently been supported by the INSPIRE Drafting Team on Data Specifications in the document D2.7: Guidelines for the encoding of spatial data, Version 2.0[49]. The application of GML and GML application schemas are in line with the development of web services.

The common standards for data exchange can be viewed and developed at different levels. This Chapter will not discuss the choice of GML as a common standard for the encoding of spatial data to be exchanged, but rather bring recommendations on how the GML standard should be exploited in the context of WISE.

5.6.2 GML – a natural choice with decisions to take

The OpenGIS® Geography Markup Language Encoding Standard (GML) is an ISO standard (ISO 19136:2007) that defines data encoding in XML for geographic data and a grammar to express models of such data using XML Schema. GML provides a means of encoding geographic information for both data transport and data storage, especially in a web context. It is extensible, supporting a wide variety of spatial tasks, from portrayal to analysis. It separates content from presentation (graphic or otherwise) and permits easy integration of spatial and non-spatial data. Clients and servers with interfaces that implement the OpenGIS® Web Feature Service Interface Standard read and write GML data.

The following diagram shows how GML would integrate with the reporting process:

[47] Document is available on CIRCA at: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/gds09sgisspolicysummary/_EN_1.0_&a=d (policy summary), and on http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/guidancesnos9sgisswgs31p/_EN_1.0_&a=d (complete guidance no.9)

[48] http://www.esri.com/library/index.html

[49] http://www.ec-gis.org/inspire/reports/ImplementingRules/DataSpecifications/inspire_dataspec_D2.7_v2.0.pdf

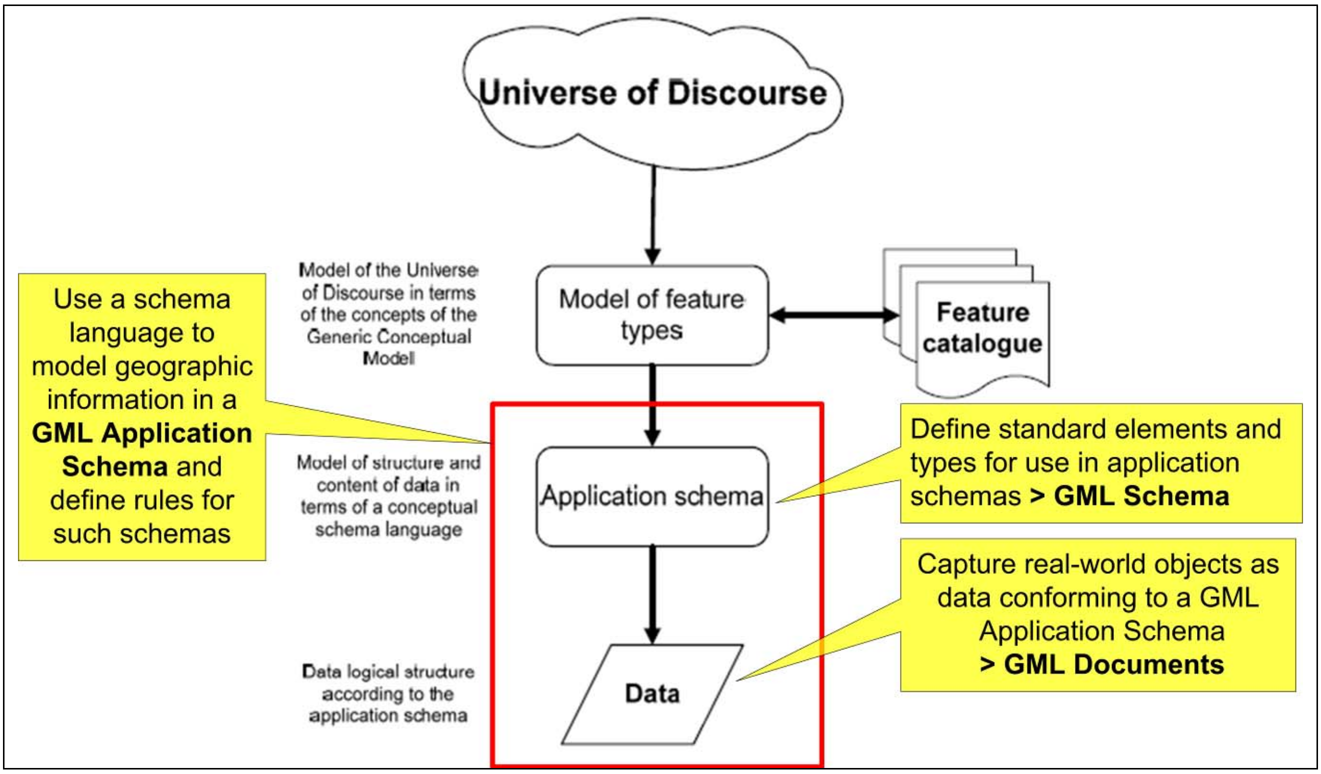


Figure 5.6.2 Development of data exchange specifications in the reporting process

The GML standard (currently version 3.2.1) is an exhaustive and flexible standard covering a wide set of possible spatial data structures and service types. It is thus beneficial both to restrict the application of GML to a common sub-set of the standards and to define a set of encoding rules to be applied to the standard. The INSPIRE Drafting Team on Data Specifications already specify, in the document D2.7, a number of recommendations on such encoding rules.

5.6.2.1 GML in a nutshell

Version

GML is jointly developed by ISO/TC 211 and OGC and published as ISO 19136:2007. The current version is GML version 3.2.1 (available from http://www.opengeospatial.org/standards/gml). GML version 3.x.x provides the option of encoding several elements: geometry properties, topology properties and time properties. A major benefit of using GML is that all necessary information can be encoded in a single GML document and be validated according to the GML application schema. No specific recommendations are provided regarding use of version. It is anticipated that the data receiver will have to implement the capability of translating more than one version.

At the time of writing GML version 3.1.1 has some advantages:

- This version is stronger than the previous version 2. by supporting e.g. topology and time;
- GML version 2 is more open and leaves several implementation choices for the same aspect;

- The software support is wider for this version than the latest version 3.2.1.

Profiles

One way of restricting the application of GML is through the application of profiles. Profiles are distinct from application schemas. Profiles are part of GML namespaces (Open GIS GML) and define restricted sub-sets of GML. Profiles are often created in support for GML derived languages (see application schemas) created in support of particular application domains such as commercial aviation, nautical charting or resource exploitation. OGC has defined a few data type specific profiles of which the Simple Features Profile[50] is recommended for WISE. The GML-Simple Feature Profile has three compliance levels: level 0, 1 and 2 (SF-0, SF-1, SF-2).

Example:

An example of the structure of GML application schemas and the encoding of elements can be found in Appendix 12.

Software support

GML is to a varying degree supported by commercial as well as Open Source GIS packages. As software is constantly developing this guidance will not provide specific software recommendations, but rather point to the OpenGeospatial[51] website for the updated information.

As GML is based on XML many of the existing XML tools may also be applied to read, write, manipulate, and validate GML documents.

5.6.3 GML and data modelling

Application schemas are XML vocabularies defined using GML and which live in an application-defined target namespace. Application schemas can be built on specific GML profiles or use the full set of GML schemas. In order to expose an application's geographic data with GML, a community or organisation creates an XML schema specific to the application domain of interest, i.e. the application schema. This application schema describes the object types whose data the community is interested in and which community applications must expose. For example, WISE may define object types of coastal water bodies, transitional water bodies etc in its application schema. Those object types in turn reference the primitive object types defined in the GML standard.

Based on the application schema, a data structure schema will be developed to facilitate the specific data exchange. Typically a GML data structure schema should include:

- Metadata section;
- Extent element;
- Features;
- Feature attributes.

[50] http://www.opengeospatial.org/standards/gml
[51] http://www.opengeospatial.org/resource/products

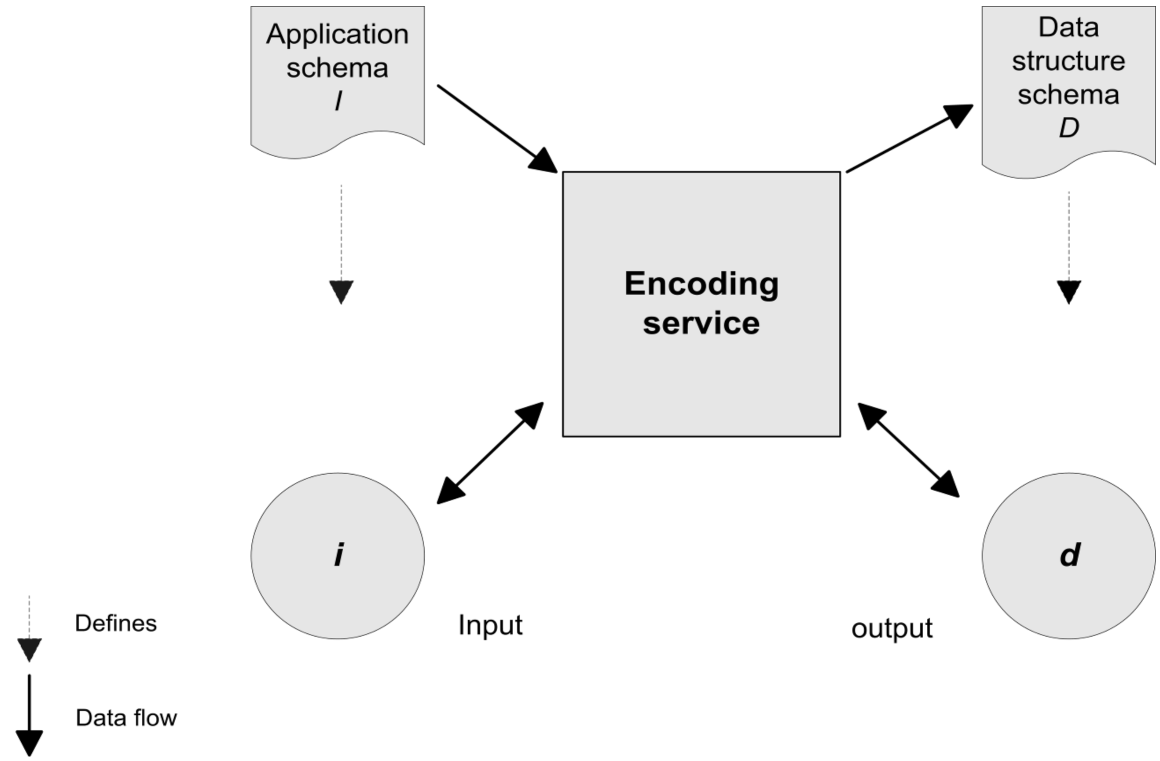


Figure 5.6.3a Overview of encoding process (ISO 19118)

Schema coding patterns for compliance level SF-0:

The schema fragments in a GML application schema that complies to GML-Simple Feature Profile level 0 are:

- Root element encoding;
- Identifying the compliance level;
- Importing and including schemas (among them the GML schema);
- Defining a feature collection (only one per application schema);
- Defining features types;
- Defining properties encoding within the feature types (including geometry properties).

The structure of each of these fragments is presented in Appendix 12.

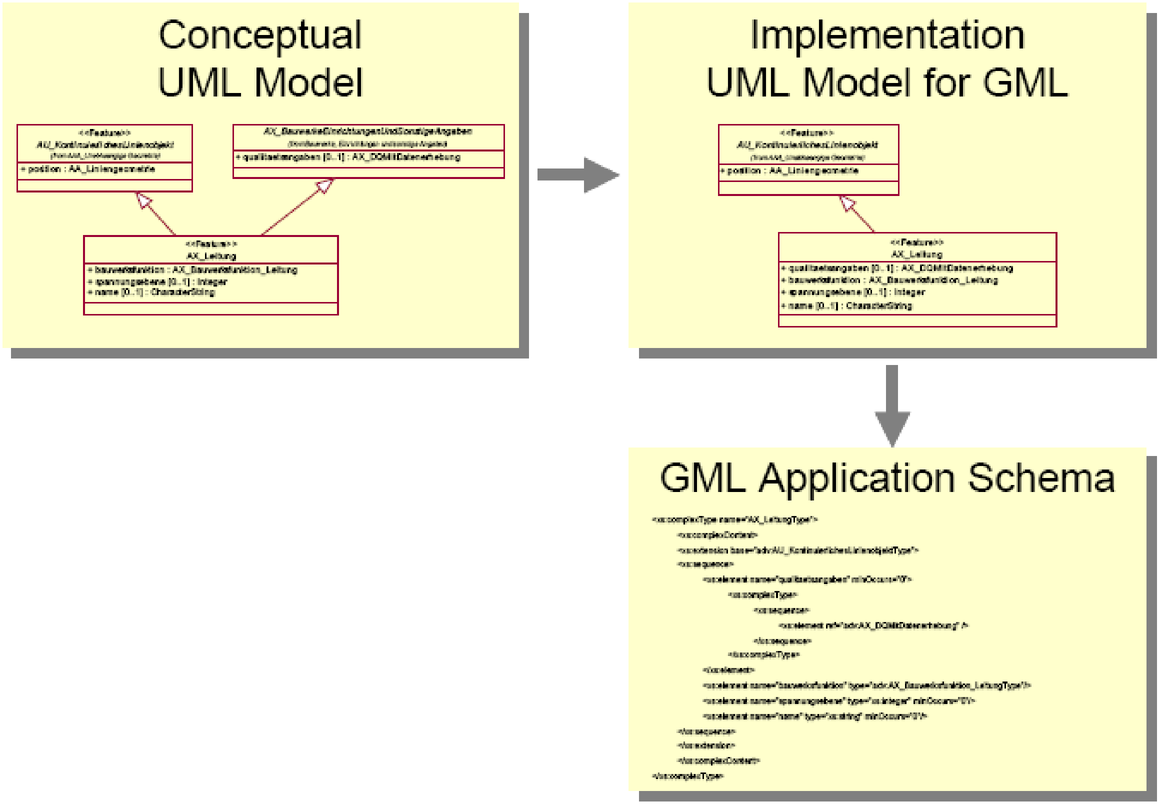


Figure 5.6.3b Process of creating the GML application schema (from INSPIRE D2.7)

5.6.4 GML in WISE

The use of GML will gradually be extended in WISE with the development of WISE GML application schemas and translation of previous Shapefile based reporting templates and schemas into data structure schemas. GML will have a role both in the further development of file based data exchange and in the development of web service specifications to be applied by the WISE and SEIS community. Figure 5.6.4 shows the relation between GML and the web services.

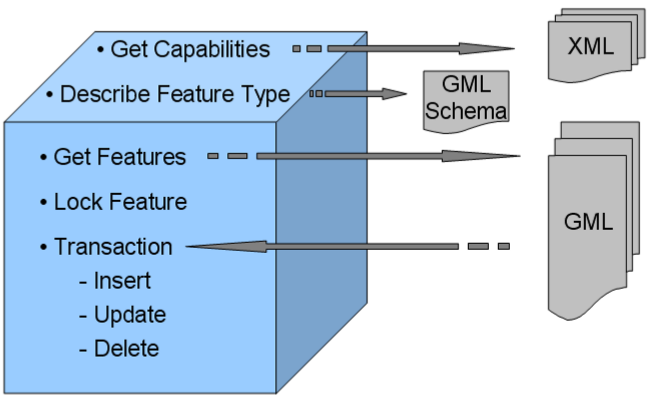
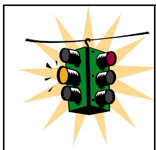


Figure 5.6.4 Relation between GML and OGC WFS web service

5.6.5 Encoding rules for WISE

During the development of GML in WISE a number of rules should be followed. The INSPIRE Drafting Team on Data Specifications has developed a set of recommendations for encoding rules in INSPIRE, a number these are adopted by WISE either directly or in a slightly modified way. The full set of recommendations (there are currently fifteen) and their details can be found in INSPIRE D2.7 Guidelines for the encoding of spatial data.



Look out!

The URN NID may change

INSPIRE work on the assumption that the URN NID “inspire” will be registered and applied. INSPIRE use ”x-inspire” as the placeholder.

In the context of WISE it still remains to be decided whether a specific namespace will be registered and which acronym it will take.

Extract of rules recommended by INSPIRE Drafting Team on Data Specifications:

- Encoding rules should be based on open standards (INSPIRE Recommendation 2);
- Additional encoding rules should only be added, if the new encoding rule has unique characteristics required by the encoded data that are not fulfilled by an encoding rule that has already been endorsed (INSPIRE Recommendation 3).

Recommendations for GML application schemas:

- The encoding rule specified in ISO 19136 Annex E should be applied. For types within the scope of the ISO/TS 19139 encoding rule, the encoding rule of ISO/TS 19139 should be applied. To identify the applicable encoding rule, a tagged value “xsdEncodingRule” should be provided for packages and classifiers. A value “iso19136_2007” (the default, if no value is provided) indicates the GML encoding rule, “iso19139_2007” indicates the ISO/TS 19139 encoding rule (INSPIRE Recommendation 5);
- The transformation from the application schema on the conceptual level to the UML implementation profile from which the GML application schema is automatically derived should follow a common set of rules across all themes (INSPIRE Recommendation 6);
- All navigable feature association roles should be assigned a tagged value "inlineOrByReference" with the value "byReference" (INSPIRE Recommendation 7).

Recommendations for XML documents:

- XML documents should be encoded using UTF-8 or UTF-16 as character encodings (INSPIRE 9).

Recommendations for the use of URNs:

- The target namespace of the GML application schema should be a URN of the form:

  urn:x-inspire:specification:<name>:<version>

  where

  <name> is a name of the GML application schema

  <version> identifies the particular version (INSPIRE Recommendation 10).

Encoding of an external identifier:

- URNs should be used to encode unique identifiers including the namespace and the local identifier part. The URNs should use the following structure:

  urn:x-inspire:object:id:<namespace>:<local identifier>[:<version>]

  where

  <namespace> is the namespace of the object identifier;

  <local identifier> is the local identifier part of the object identifier;

  <version> is an optional version qualifier to be added only if a specific version of the object shall be identified. (INSPIRE Recommendation 11)

Encoding of a reference to a spatial object:

- To reference a spatial object or a specific version of a spatial object the URNs specified in Recommendation 11 should be used (INSPIRE Recommendation 12).

Encoding of a reference to a registered item:

- URNs should be used to encode item identifiers of items in registers and to reference such items.

  The URNs should use the following structure:

  urn:x-inspire:def:<item class>:<register>:<item identifier>

  where

  <item class> is the name of the item class (ISO 19135: RE_ItemClass) of the registered item;

  <register> is the name of the register (ISO 19135: RE_Register);

  <item identifier> is the item identifier of the registered item (ISO 19135: RE_RegisterItem).

  Other URIs may be used, too. It is recommended to register them as an alias of the item in the INSPIRE register (INSPIRE Recommendation 13).

Modified INSPIRE rules:

- To support interoperability and enhance coherence across communities, the encoding rules and output data structure schemas in WISE should be as consistent across the various themes as possible (INSPIRE Recommendation 1);
- For every WISE application schema, a GML application schema should be specified (INSPIRE Recommendation 4);

- All code lists should be assigned a tagged value "asDictionary" with the value "true". Instance should reference the WISE register that is used to manage this code list (INSPIRE Recommendation 8).

Rules for exchange of metadata:

- For data transfer, using the transfer model (download of a complete spatial dataset), the dataset should include the dataset metadata for evaluation (MD_Metadata as specified in the WISE data specification) and use (INSPIRE Recommendation 14);
- For data transfer, using the interoperability model (download of a spatial objects based on a query), the response of the download service should not include any dataset metadata but should provide a reference to the dataset or dataset series metadata in a discovery or registry service (INSPIRE Recommendation 15).

WISE-specific rules:

- Although GML allows more than one geometry to represent a feature which could lead to, for example, water bodies that are presented as point features and as Linestring or Polygon feature, WISE recommends separating each geometry type in different GML documents which will keep it simple to manage the upload and metadata of exchanged data

5.6.6 Role of Shapefiles in WISE

The available reporting interfaces developed between 2004 and 2007 were based on Shapefile formats and XML schemas as a bundle completing the electronic reporting content on Articles 3, 5 and 8 of the Water Framework Directive. These reporting interfaces will remain for updating the information on the mentioned Articles under the first River Basin Management Plan and following reporting phases. Alternatively GML schemas (covering the content of the Shapefile formats and XML schemas) can be used to substitute the former reporting formats. The GML schemas will be made available by the EEA as they are developed.

The use of GML in WISE will gradually be extended and further use of Shapefiles will not be stimulated. Although quite widespread the Shapefile format has some major disadvantages:

- No validation rules can be applied directly to the set of files;
- The format does not fit into the service oriented architecture;
- Problems with controlling and determining the character set applied in attribute tables;
- Multiple files needed for transmitting a single theme;
- Vendor-specific origin (though openly documented).

5.7 Web services

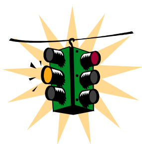
5.7.1 What are spatial data web services

5.7.1.1 Service definitions

Network services are designed to perform machine-to-machine communication which may be embedded in end user applications. The primary purpose of the network services is to provide information in a standardised way independent of the underlying application software, platform or framework.

Spatial data may be disseminated and shared in real-time through the use of these web-based network services. Open Geospatial Consortium, Inc (OGC) has drafted a number of OpenGIS® Web Service (OWS) interface specifications. These service specifications have been widely adopted by the user community, ISO, CEN and INSPIRE.

Each of the network services is implemented using a specific interface specification. Examples of such interfaces are OGC-WMS (Web Map Services), OGC-WFS (Web Feature Services) etc. described further in Chapter 5.7.2. From a user perspective the various network services together should be able to support a workflow following a “publish – find – bind” design pattern. However, users do not necessarily have to follow this pattern; they can also invoke services directly.



Look out!

Definition OGC Web Services (One Geology)

An OGC Web Service (OWS), or open web service, is a ‘self-contained, self-describing, modular application that can be published, located, and invoked across the web. Web services perform functions that can be anything from simple requests to complicated business processes. Once a web service is deployed, other applications (and other web services) can discover and invoke the deployed service.’ (Ref: OGC).

Typically a web server is a computer placed on the Internet that offers an OGC Web Mapping Service or WMS (responds to requests from a computer client to send a map in the form of a raster or image over the Internet) and/or an OGC Web Feature Service or WFS (responds to queries from a computer client to send an application of GML representation of some data often with a geographic part in an XML document based on a schema such as GeoSciML).

A web server can publish more services than WMS and WFS and there are other OGC web servers that publish mapping services.

The OGC WMS specification standardises the way in which web clients request maps. Clients request maps from a WMS instance in terms of named layers and provide parameters such as the size of the returned map as well as the spatial reference system to be used in drawing the map.

	The OGC WFS specification supports INSERT, UPDATE, DELETE, QUERY and DISCOVERY of geographic features. WFS delivers GML representations of simple geospatial features and other feature attributes in response to queries from HTTP clients. Clients access geographic feature data through WFS by submitting a request for just those features that are needed for an application.

5.7.1.2 Services within Spatial Data Infrastructures

Thanks to new legislation such as INSPIRE and several initiatives to (re)use geographical data more efficiently, the concept of Spatial Data Infrastructures (SDI) has gained more attention. Network services are seen as one of the core elements of SDIs and are paramount in fulfilling the target of interoperability and data distribution.

The conceptual organisation (i.e. the logical architecture) of the services within an SDI is still subject of discussion. Two major examples of possible architectures are the INSPIRE Network Services Architecture[52] drafted by The INSPIRE Network Services Drafting Team and the Web Service Architecture (WSA)[53] which is a standardised architecture for services on the Internet and is drafted by the W3C. Figure 5.7.1.2 provides an overview of the INSPIRE Network Services Architecture.

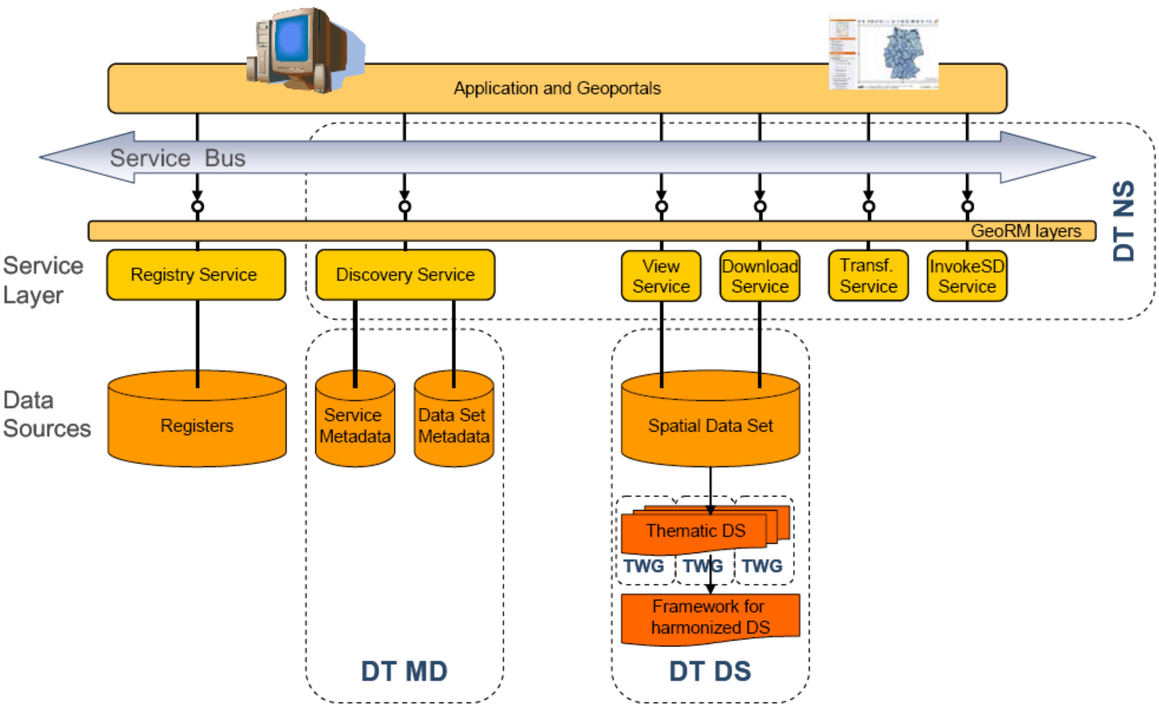


Figure 5.7.1.2 Overview of the INSPIRE Network Services Architecture

The INSPIRE Network Services Architecture aims at providing guidelines towards all initiatives in Europe that implement SDIs under the umbrella of the INSPIRE

[52] http://www.ec-gis.org/inspire/reports/ImplementingRules/network/D3%205_INSPIRE_NS_Architecture_v2.0.pdf
[53] http://www.w3.org/TR/2004/NOTE-ws-arch-20040211/

legislation and the related implementation of this European initiative by Member States.

The control of access from applications and GeoPortals to view and exploit spatial data services is, under the INSPIRE Network Services Architecture, performed through the Geo Rights Management layer (GeoRM), see Figure 5.7.1.2. The GeoRM should allow public authorities to electronically specify licence terms and conditions in such a way which supports the automated transfer of legal rights to use the spatial data or service, provide services to enable e-government integration of network services, manage authentication, authorisation, pricing, billing, logging, etc.

5.7.1.3 Software

OGC Web Services are to a varying degree supported by commercial as well as Open Source GIS packages. As software is constantly developing this guidance will not provide specific software recommendations, but rather point to the OpenGeospatial[54] website for the updated information.

5.7.2 Types of web services

Architecture of services ISO 19119 classifies the services as follows:

- Human interaction services (GIS clients, Geo Portals, catalogue clients, etc, also WS-BPEL viewers for workflow definition);
- Model/Information management services (management and access to data, WMS, WFS, CSW, etc);
- Workflow services (chain definition and enactment such as the WS-BPEL standard);
- Geo-processing services (spatial, thematic, temporal and metadata);
- Communication services (encoding and infrastructure, application servers and Enterprise Service Bus ESB).

The INSPIRE Network Services Architecture classifies the network services slightly differently and uses more a usage perspective.

The following services are defined in INSPIRE: (text taken from D3.5_INSPIRE_NS_Architecture_v2.0.pdf):

- **Discovery services:**

  Discovery services make it possible to search for spatial data sets and services on the basis of the content of the corresponding metadata and to display the content of the metadata. Within the geographic community various names have been assigned to instruments for discovering spatial data and services through the metadata properties; examples are Catalogue Services, Spatial Data Directory, Clearinghouse, Geographic Catalogue and Geodata Discovery Service. In INSPIRE these services are referred to as Discovery Services. The goal of discovery is to support discovery, evaluation and use of spatial data and services through their metadata properties. Metadata is the information

[54] http://www.opengeospatial.org/resource/products

and documentation, which makes these resources understandable and sharable for users over time. Indexed and searchable metadata provide a controlled vocabulary against which discovery can be performed. INSPIRE Discovery Services shall provide the functionality for users both to manage and search catalogues or the purpose of discovery and evaluation within the context of the INSPIRE Directive. The network of services should also include the technical possibility to enable public authorities to make their spatial datasets and services available. The INSPIRE Directive specifies that Member States shall ensure that public authorities are given the technical possibility to link their spatial datasets and services to the network. This 'linking' service is also offered in the context of a discovery service as a capability of the discovery service.

- **View services:**

  View services make it possible, as a minimum, to display, navigate, zoom in and out, pan or overlay viewable spatial data sets and to display legend information and any relevant content of metadata". Member States shall ensure that e-commerce and GeoRM services are available for view services if required.

- **Download services:**

  Download services will enable copies of spatial data sets, or parts of such sets, to be downloaded and, where practicable, accessed directly. In addition, where public authorities levy charges for the download services, Member States shall ensure that e-commerce and GeoRM services are available.

  A download service supports:

  - Download of a complete dataset or datasets; or
  - A part of a dataset or datasets; and
  - Where, practicable, provide direct access to complete datasets or parts of datasets;
  - Gazetteer-like services are also covered by a type of download service.

- **Transformation services:**

  Transformation services, enable spatial datasets to be transformed with a view to achieving interoperability.

- **Invoke spatial data services:**

  The Invoke Spatial Data Service allows the definition of both the data inputs and data outputs expected by the spatial service and define a workflow or service chain combining multiple services. It also allows for the definition of the external web service interface of the workflow or service chain.

Guidance from INSPIRE

The INSPIRE roadmap[55] foresees the development and implementation of INSPIRE Implementing Rules (IR) for each of the service types. The timeline for services is

[55] http://www.ec-gis.org/inspire/inspire_roadmap.cfm

outlined in Table 5.7.2. Based on the roadmap it is anticipated that more specific guidelines in relation to WISE nodes will be provided in later amendments to this guidance document. It should be noted that the INSPIRE IR will not prescribe a specific service implementation (e.g. WFS) but rather specify the interfaces requested from the various types of INSPIRE services.

Table 5.7.2 INSPIRE Implementing Rules (IR)

Milestone date	Description
IR adoption	
2008-11-15	Submission for opinion of the INSPIRE committee of IR for discovery and view services
2009-05-15	Submission for opinion of the INSPIRE committee of IR for download services
2009-05-15	Submission for opinion of the INSPIRE committee of IR for coordinates transformation service
2010-05-15	Submission for opinion of the INSPIRE committee of IR for schema transformation and "invoke spatial data service" services
IR implementation	
2010-11-15	Discovery and view services operational
2011-05-15	Download and Coordinates transformation services operational
2012-11-15	Schema transformation and "invoke spatial data service" services operational

5.7.3 How web services will expand the WISE coverage

5.7.3.1 WISE distributed system

Since January 2008 discussions have started to establish an architecture for the WISE distributed system (WISEds). The WISEds is based on GIS web services and will allow the WISE community to work according the INSPIRE regulations.

To understand the use of web services in WISE one has to differentiate between a REPORTING and a DISSEMINATION flow;

- REPORTING will be defined as the data flow from Member States to the European commission;

- DISSEMINATION will be defined as the data flow out from the WISE database.

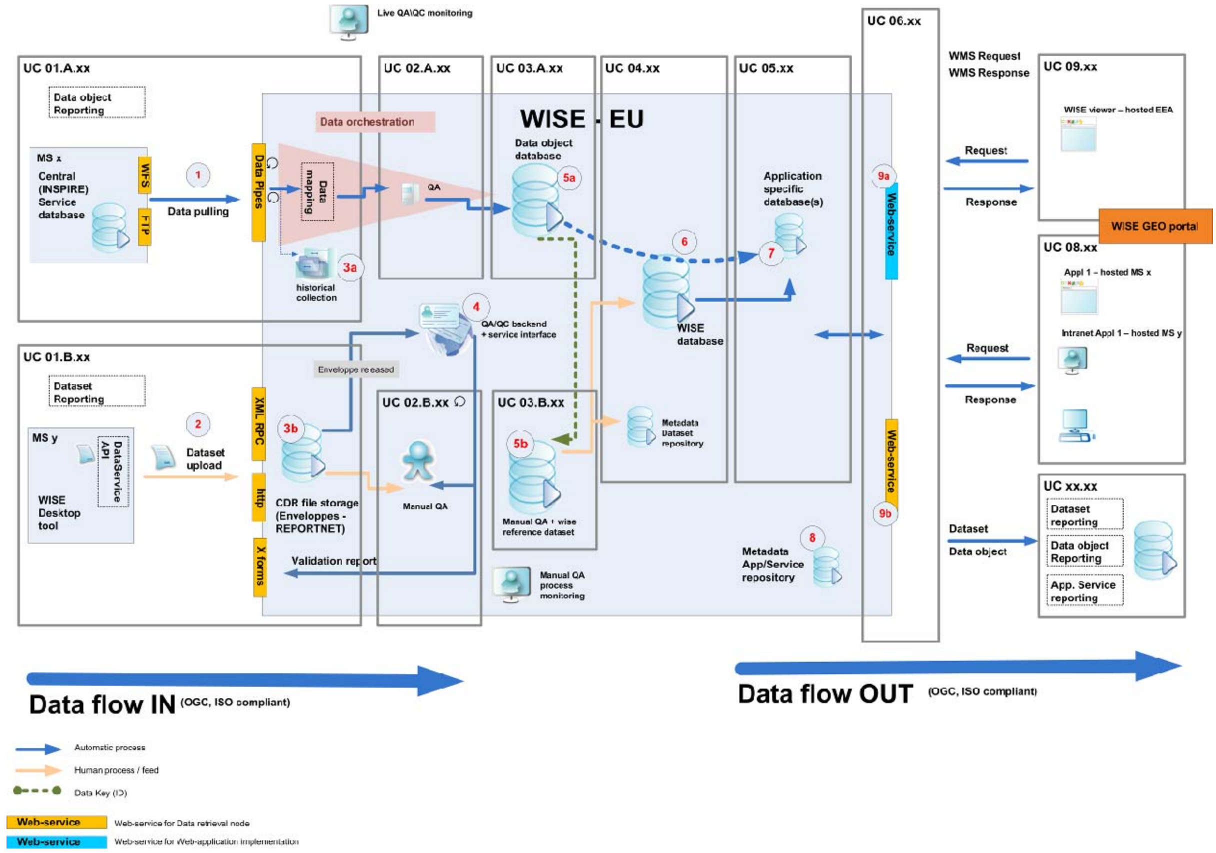


Figure 5.7.3.1 Overview of WISE distributed system

5.7.3.2 REPORTING data flow

Figure 5.7.3.2 illustrates how four types of REPORTING data flow can be distinguished based on the amount of data and the transaction frequency.

	High frequency	Low frequency
Object based	Type I	Type II
Dataset based	Type III	Type IV

Figure 5.7.3.2 Data reporting types

At present WISE is almost only using Type IV data flows organised through a file based exchange mechanism (Reportnet). This type of communication will continue to exist in the future. However the introduction of GIS web services into WISE aims at opening the REPORTING data flow towards all other types and to introduce new possibilities for Type IV. Typical usage of each type are:

- Type I: This type of communication could occur when a Member State reports any change they make in their database related to WISE data. It means that every transaction in the central database of the Member States is directly pushed to the WISE distributed system. Each transaction might have a single object (record) or a limited list of objects. It also should be related to datasets that are changing frequently, such as weekly bathing water quality measurements;
- Type II: A typical data flow could be the update of a River Basin District. A single object is reported but most likely a Member State is not updating its River Basin Districts every month;
- Type III: This is a less common type but could be used to exchange, for example, aggregated datasets;
- Type IV: Some Member States might have revised the complete dataset of their rivers (new surveys). In this case the Member State reports a complete dataset on a certain topic. Based on WFS and GML based SOAP services upload mechanisms could be foreseen to handle this type of input data.

How these new types of data flow will be implemented is still subject of discussion as it relies on the implementation rules of INSPIRE, which are still being drafted, and several stakeholders are involved with the set-up of the infrastructure which requires strong coordination and consultancy.

5.7.3.3 DISSEMINATE data flow

The DISSEMINATE data flow will be used to disseminate the data that has been collected and processed under the reporting obligations covered by WISE. The flow is the machine-to-machine complement to the human interfaces of the WISE map viewer and will distribute all WISE data with a public access license.

The Member States can expect download, view, discovery etc services from the WISE output service node. The detailed specifications of each service will be defined based on:

- Current services provided by the WISE website;
- New user requirements;
- SEIS implementing rules (when available).

Member States that have the interest or capability may integrate the WISE web services directly into their own applications.

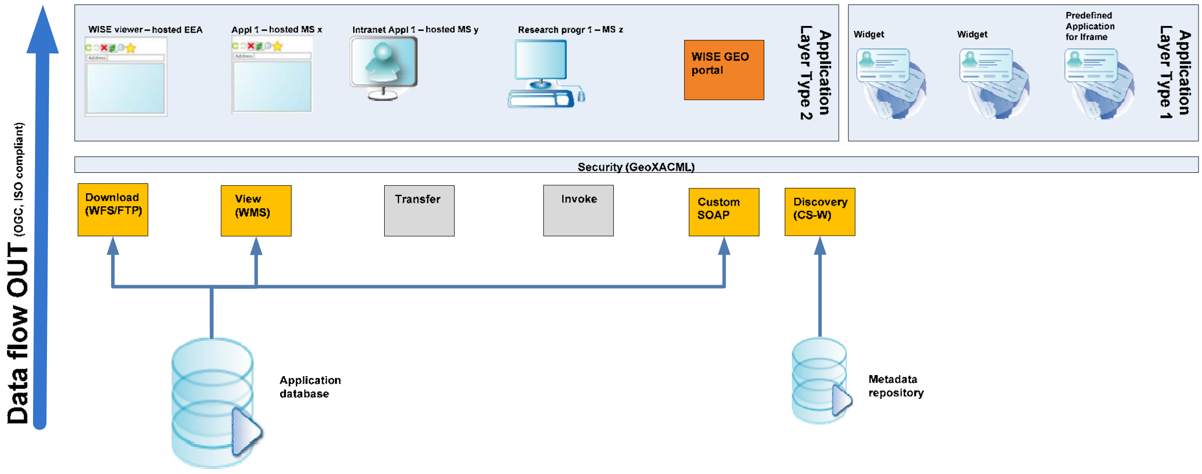


Figure 5.7.3.3 DISSEMINATE Data Flow

5.7.3.4 Role of MS provided web services

WISE compliant web services provided by the Member States will complement the WISE map viewer in several ways:

- Web services with data according to common WISE specifications will provide access to up-to-date information operationally in use in the Member States;
- National web services with data outside the scope of WISE specifications can extend the information available to the European users in two dimensions:
    - The granularity of information may be expanded, so the full set of information available at the Member State level may be exploited rather than a potentially sub-selected and aggregated set reported. The WISE map viewer currently operates with a threshold of scale 1:250,000 when providing web map services. Data with a better resolution should be provided and visualised by connection to national SDI nodes;
    - Feature types and parameters outside the WISE data specifications may be made available outside the Member State. These parameters and features could, for example, relate to the locally relevant pressures, monitoring data, potential measures or socio-economic conditions.

5.7.4 Recommendations for the set up of WISE compliant nodes

Member States that wish to extend the WISE coverage with national web services are encouraged to do so. While INSPIRE IR are not yet in place some recommendations can be given for implementation in the short term, as follows:

Software:

- WMS services should be implemented using SLD compliant software to allow a common (client specified) symbology to be applied.

Services to be provided:

- It is recommended that the data provision services as WFS, WMS and download services are established (see also data policy below);
- The services should be provided using the application schemas developed in WISE;
- Services outside the scope of WISE should be documented in English;
- Metadata services should be available from WISE and from the Member States;
- Service registry will be available from WISE.

Data policy:

- Provision of a spatial dataset specified as Member State submissions under European legislation should always be provided as free and open WFS and be downloadable;
- National spatial data established in relation to the implementation of water environmental policies should, as much as possible, be provided as free and open WFS and download services alternatively as WMS services.

A manual on the set-up of a WISE service node will be drafted once the architecture of the WISE distributed system is defined in detail and has been tested for robustness, scalability and performance.

6 Harmonisation

6.1 Validation and harmonisation of geometry, data definitions, data models, naming

Given that WISE is aimed at multiple use of the information reported from MS, the importance of harmonising has increased. The target of having comparable quality in data submissions from MS for assessment of compliance as well as the basis for developing reference datasets at the European level requires a common understanding of the harmonisation and validation procedures required.

Harmonisation of the national submissions has so far been one of the most resource consuming tasks at European level.

6.1.1 The purpose of harmonisation and validation of MS data

There are several reasons for harmonising MS data into common European data specifications:

- By conforming to European specifications the MS ensure that the provided data comply with the requirements given by the directives and other requests calling for the data;
- The Commission can streamline their evaluation of MS compliance with a directive when the input data conform to a common set of specifications;
- The Commission can streamline the process of producing and updating the pan-European WISE Reference GIS datasets from the MS submitted data;
- A streamlined process is particularly important when datasets are being updated or resubmitted;
- Harmonised data is a requirement for comparable analysis, reporting and visualisation of the European state of implementation of directives and state of the environment reporting;
- Working with harmonised datasets reduces the risk of misinterpretation as the harmonisation process ideally eliminates the national differences in data structures, encoding data schemas and level of detail.

Harmonisation starts at the MS/RBD level, where the primary information is available. A part of the harmonisation may take place at either MS level or EC level. The validation of data submitted by the Member States is the first step of the verification that the MS are fulfilling the requirements of reporting specified in the directives in question. Secondly, a data quality assessment to ensure that the data are of sufficient quality for further application has to be made. Finally, a single harmonised feature dataset can only be produced at the European level. Figure 6.1.2 depicts where the various processes takes place.

6.1.2 Harmonising MS data for submission to WISE

Harmonisation of data in the Member States prior to submission into WISE is the most crucial part of the harmonisation process. As the data specifications from the implementing rules of the INSPIRE Directive have not yet been implemented, the data collections at MS level will be of varying structure, thematic content and quality.

The starting point is the selection of a spatial dataset covering the proper spatial object type (monitoring stations, river segments etc.) and having a resolution complying with the data specification.

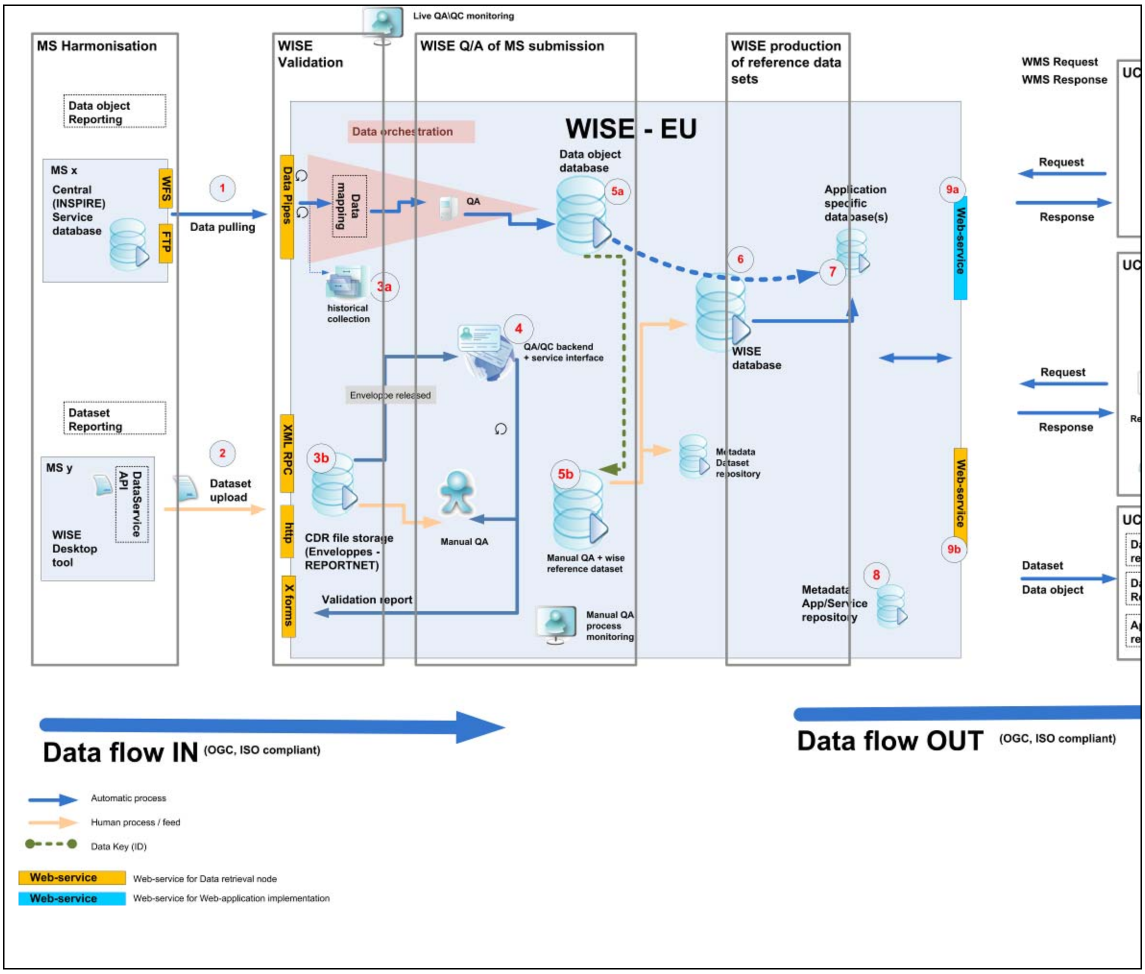


Figure 6.1.2 Harmonisation and validation processes in the WISE architecture. (Detailed explanation in the WISE architecture document available from https://svn.eionet.europa.eu/projects/Reportnet/wiki/WiseDS)

Member States have, in many cases, several spatial datasets with the proper object type. The dataset to be used will be selected on criteria such as:

- Having a level of detail and resolution similar to or better than requested;
- Being up-to-date;
- Having an operational use in the relevant national implementing authorities;
- Having features attributes that either contain similar feature attributes as specified or can, through feature identifiers, be linked to such information.

Spatial reference system transformation:

MS should deliver the spatial dataset in the agreed coordinate reference system (see Chapter 5.1.3) using ETRS89 as the geodetic datum and using ellipsoidal coordinates (decimal degrees).

As experience has shown that the transformation formulae from the national coordinate reference system to the ETRS89 system in some areas are less accurate, it is recommended to validate the transformation using e.g. boundary data from the EuroRegionalMap. The feature harmonisation with neighbouring regions/countries may also be used as a part of this validation.

Feature harmonisation:

Harmonisation of features to the data specifications has two main elements:

Harmonisation of features with neighbouring regions and countries:

The RBDs and MS are expected to deliver data that has been harmonised with the neighbouring countries/RBDs. Experience still has to be gained to identify the usage of River Convention data. Appendix B of the INSPIRE document D2.6 Methodology for the development of Data specifications, provides recommendations regarding harmonisation of continuity of linear and polygon features across borders.

Member States will report spatial datasets to EU bodies under various articles of the WFD. These datasets come from national repositories which are not necessarily geometrically aligned across national borders or to a pan-European coastline. To connect borders of River Basin Districts or rivers across national borders, one option for Member States will be to align their data with a selection of EuroRegionalMap at scale 1:250 000. This data selection essentially comprises the national borders, the coastline and hydrological features that cut across national borders. Member States will be able to download these data sets free of charge from a dedicated section of WISE provided they do not use these data for any other purpose. Download will be restricted to authorised persons in the water authorities.

As recommended in Chapter 5.1.3.3. Member States need not to simplify their datasets before submitting to WISE. Thus, if agreed within the respective RBD, also larger scale data can be used for the geometrically alignment across national borders. EU bodies will align these submissions to EuroRegionalMap.

Feature attribute harmonisation (schema transformation)

The feature attribute names and associated code lists in the national databases will rarely be the same as specified in the WISE application schema. The harmonisation will require a transformation of the national database schema into the application schema and similarly a transformation of the feature attribute values to fit into the code lists of both the data model and the data dictionary. The XML schemas and end-user tools support the correct feature attribute transformation by applying code lists and schemas.

Format transformation:

The GIS data and the associated feature attributes should be converted to either shape files or GML according to the Data Structure schema specified for the specific reporting obligation. More details on GML may be found in Chapter 5.6.

File naming:

Applying common file naming conventions helps streamlining the validation process when data is received into the WISE system. The file naming include the following elements:

- Country ID;
- River Basin District ID;
- Feature set name;
- Date.

Specific guidelines for the naming of files will be included in short GIS reporting guidelines for each reporting obligation.

6.1.3 WISE validation of MS submissions

The validation of a MS submission ideally takes place immediately after the upload of data. The validation process is a set of technical tests to check whether or not data conform to the data specifications.

Validation steps:

- Does submission include the expected files?
    - Is the naming of files in line with the specifications?
    - If the submission is split into more than one region – are all regions provided?
    - If the submission is split into several themes – are all themes provided?
- Is each set of files complete and in conformance with the specifications?
- Within each set of files:
    - Is the type and format of files correct?
    - If the delivery is in XML:
        - Can the file be validated against the defined application schema?
- Metadata:
    - Do the referenced data sets exist in WISE?
- Spatial coverage:
    - Is the spatial reference system documented and in conformance with the data product specifications?
    - Does the provided spatial data set have the expected coverage (MS, River Basin District, Sub-unit etc.)?
    - EuroRegionalMap should be applied to verify that:
        - all features fall inside the proper territory (evaluated within the tolerance of the spatial accuracy)

        - that features with continuity into neighbouring countries have an end-point on the border (evaluated within the tolerance of the spatial accuracy).

- Feature attributes (If the delivery is in non-XML format):
    - Have the right feature attribute names been defined?
    - Are mandatory feature attributes given valid information?
    - Are attribute values, including size, within the specified domain?
- Feature associations:
    - Do features that are referenced to through matching feature IDs exist (previous deliveries or other feature data set in same submission)?
    - Is there consistency between the feature extent and the position/extent of the referenced features (e.g. is a monitoring station situated inside the RBD it belongs to)?
- Topological relations:
    - Does the coverage fulfil the topological rules defined for the feature data set – e.g. no gaps and no overlaps between features, connected features etc?

Determining data quality:

The spatial data submitted by the MS should in general comply with:

- Fitness for use. The data submitted by the MS should fit the requirements expressed in the Reporting sheets (to be replaced by the Consolidated Guidance on Reporting) and data specifications;
- Customer satisfaction (in close relationship with the previous point). The final layer should satisfy the expectations of the MS with regards to the WISE reference layers;
- Conformance to requirements, standards and expectations.

After the MS submission, it is a requirement to have a clear assessment of:

- Completeness (contains no missing features or values);
- Consistency;
- Accuracy (closeness to reality);
- Resolution.

Discovering errors:

Two forms of analysis should be undertaken:

- Exploratory – look for the unusual;
    - Visual checks: completeness, positional accuracy, etc.;
        - Verify: spatial reference, scale, resolution, positional accuracy, existence of metadata (following standards), completeness of the metadata, etc.

- Confirmatory – verify rules and criteria have been met;
    - Automated checks: To discover geometry/topology/attribute errors, supported by the use of GIS tools.

6.1.4 Harmonisation at European level:

Harmonisation at the European level has the purpose of producing a single feature dataset of homogenous quality according to an application schema. If the European dataset is to be produced with the same specifications as MS deliveries, the process is ideally a simple merge of national submissions that only should consider duplicated features forming the borders between MS.

A few manual checks may however be applied, if they are not already integrated as a part of the validation process:

- Does the variation in the density of features across each Sub-unit, RBD, MS and Europe as a whole reflect the expected variation or have e.g. the data-capturing rules been applied differently?
- Is there continuity of matching features of same object meeting at the border (rivers or lake borders)?
- Where the border is formed by a feature (river or lake) there is a risk of duplication:
    - Do they share same geometry, can one geometry be substituted by the other or should they be dissolved into a single geometry?
    - Transmission of feature attribute values from both countries to a harmonised feature.

6.2 Production of the WISE Reference GIS datasets

The WISE Reference GIS datasets are managed and maintained by the EEA and have been compiled from data provided by Member States under WFD Articles 3 and 5, or, in the case of Sub-units, at the request of the European Commission.

Some additional processing is applied to the data provided by the Member States, where necessary, in order to produce the WISE Reference GIS datasets, including:

- The harmonisation of ‘duplicate’ features and geometrical inconsistencies at national borders using EGM (up to 20% of the features[56]) or ERM (up to 10% of the features;
- Complementation of geometries using ERM data where data provided by MS do not fulfil the WISE Reference GIS dataset specification;
- The selection of rivers with specific catchment areas from submitted data using CCM2.1 or the EEA’s European River Catchments (external GIS datasets);

[56] Due to copyright restrictions, Eurogeographics allows for public distribution of parts of EGM and ERM (20% and 10% of features, respectively). If a larger share of the features in a feature class is used the resulting dataset cannot be publicly distributed.

- The application of consistent and stable hydrological codes to features in order to successfully manage the linkages between WISE Reference GIS datasets.

Many Member States are already involved in bilateral co-operation agreements with, for example, International River Commissions, in an effort to harmonise their data and resolve geometrical inconsistencies at national borders. Data resulting from these important agreements will be beneficial for the production of WISE Reference GIS datasets and MS are encouraged to document/identify when the submitted data are outcomes of such agreements.

The European Commission is in the process of reviewing the WFD Articles 3, 5 and 13 Reporting sheets with the aim of producing a consolidated Guidance on Reporting in time for the reporting of RBMPs under Article 13. This may require Article 3 and 5 data resubmissions from MS where there were gaps in the original submissions or where details have changed. The aim is to produce a more efficient and streamlined reporting system through WISE in the future.

In the following Chapters, the processing of WISE Main Rivers and Main Lakes are provided as examples.

6.2.1 Approach for the processing of the WISE Main Lakes and Main Rivers layers

6.2.1.1 Main Lakes:

The development of the Main Lakes layer for WISE is based on the objects reported by the Member States under WFD Articles 3 and 5 complemented with data from ERM (EuroRegionalMap v2.0).

Two main issues are related to the processing of WFD Articles 3 and 5 data into the WISE Main Lakes dataset:

- The size criterion for WFD Article 3 Main Lakes is different from the WISE Main Lake specification (lake surface area of 100 km^2 versus 10 km^2).
- Lake Water Bodies reported in WFD Article 5 may be reported as centroids instead of polygons. Furthermore, does the definition of a Lake Water Body allow for the option that a) a lake may be divided into more than one Lake Water Body and b) a Lake Water Body may consist of more than one lake.

Since the WFD Articles 3 and 5 data are not in all cases sufficient to build the polygon layer of WISE Main Lakes, an additional layer has been taken into account. The ERM (EuroRegionalMap[57] v2.0 - feature class LakesresA) was selected as that additional layer.

The main objective for the production of the WISE Main Lakes layer is a good set of geometries representing the lakes submitted by Member States under Articles 3 and 5. As the same lake might be represented differently in the input layers a list of priorities has been established:

- First priority - WFD Article 3 Main lakes;
- Second priority – WFD Article 5 Lake Water Bodies;

[57] http://www.eurogeographics.org/eng/04_products_regionalmap.asp

- Third priority – ERM, feature class LakesresA.

The main principle has been that if a lake with a surface area above 10 km^2 has not been delivered as a polygon feature under either WFD Articles 3 or 5 then the proper geometry has been selected from ERM using WFD Article 5 centroids. The workflow of the processing the geometries of the features is summarised in Figure 6.2.1.1.

The results of processing the WISE Main Lakes layer were:

- Total number of lakes based on Articles 3 and 5 submissions: 9822 lakes;
- Main Lakes (Area ≥ 10km2): 856 lakes, where:
    - 576 geometries (67.3%) originate from Articles 3 and 5;
    - 280 geometries (32.7%) originate from ERM.

More information about the input layers, GIS processes applied and the methodology will be made available from the WISE web site.

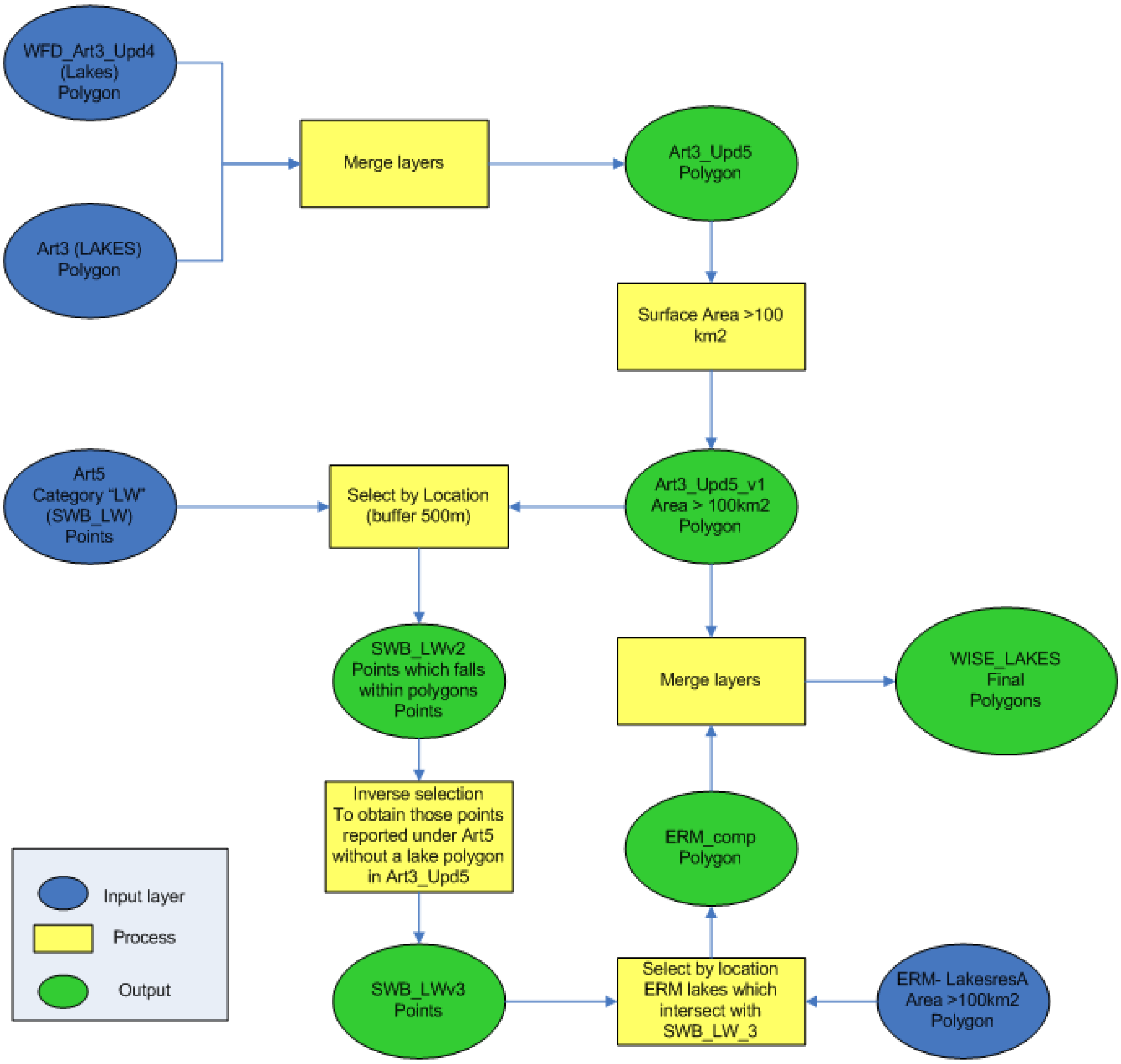


Figure 6.2.1.1 GIS workflow for the construction of the Main Lakes layer based on Articles 3 and 5 submissions and ERM v2.0. Lakes with an area equal or larger than 10 km2 are considered to be Main Lakes.

6.2.1.2 Main Rivers

As for lakes, the development of the Main Rivers layer for WISE is based on the objects reported by the Member States under WFD Articles 3 and 5, complemented with data from ERM (EuroRegionalMap v2.0). Catchments from CCM2.1 are used to ensure a consistent data capture criteria throughout Europe.

A number of issues are related to the processing of WFD Art. 3 and Art 5 data into the WISE Main Rivers dataset:

- Although the WFD Article 3 Main Rivers and the WISE Main Rivers have the same catchment size criterion (catchments > 500 km^2) an overview of the submitted data show differences;
- River Water Bodies reported in WFD Article 5 may be reported as centroids instead of polylines. Furthermore does the definition of a River Water Body allow for the option that:
    - a river/ river segment is divided into more than one River Water Body and;
    - a River Water Body may consist of set of rivers/river segments.
- As WFD Article 5 data consists of water bodies for evaluation of ecological status, continuity through lakes and heavily modified stretches is not ensured.

Analysis of the data submitted by the Member States revealed several problems, basically due to quality aspects, completeness, geometry consistency, connectivity, attributes, etc. More information about the input layers, error analysis, GIS processes applied and the methodology will be made available from the WISE web site.

Since the WFD Articles 3 and 5 data are not in all cases sufficient to build the WISE Main Rivers layer with a connected set of rivers for all rivers with a catchment area above 500 km^2, a complementary layer, ERM (EuroRegionalMap v2.0 (feature class WaterCourses) has been selected.

The input GIS layers used for the analysis and for the development of the methodology are:

- Article 3 submissions (and its update) line feature classes;
- Article 5 submission (point and line type geometries);
- ERM v2.0 (WaterCourses) as complementary source of features.

The main objective for the production of the WISE Main Rivers layer is a good set of geometries representing the rivers submitted by Member States under Article 3 and Article 5. As the same river might be represented differently in the input layers a list of priorities has been established:

- First priority - WFD Article 3 Main Rivers;
- Second priority – WFD Article 5 River Water Bodies;
- Third priority – ERM, feature class WaterCourses.

The main principle has been if the Main River in a catchment with an area greater than 500 km^2 has not been delivered as a polyline feature under WFD Articles 3 or 5 then the proper geometry has been selected from ERM using WFD Article 5 centroids. In the future, Member States may provide features that may supersede the ERM features.

If the aggregation of the geometries of the selected Articles 3 or 5 data do not result in a continuous geometry, complementary data are obtained from the ERM data. If neither river segments nor water body centroids are present for a CCM2.1 catchment with an area greater than 500 km^2, ERM data are also used.

6.3 WISE reference features for visualisation

6.3.1 Purpose of WISE reference features for visualisation

WISE reference features for visualisation are features such as River Basin Districts or water bodies available in a European wide topological harmonised dataset (WISE Reference GIS dataset). They will be used to:

- Visualise data reported by Member States in a harmonised way;
- Provide comparable units for data analysis and the development of indicators.

WISE reference features can also be used to link tabular reported data and information to GIS data that is already available in WISE. The reference established between WISE reference features and Member State reported data will be either:

- The reference between different features based on a specified relationship (e.g. Member States reported river monitoring stations to WISE reference river water bodies); or
- The reference between the same entities:
    - o Either between Member States reported not harmonised GIS data and harmonised WISE GIS datasets (Member States River Basin Districts to WISE River Basin Districts); or
    - o Between Member States reported tabular information and harmonised WISE features (e.g. status information on Groundwater bodies to WISE Reference Groundwater bodies; data reported for WISE-SoE monitoring stations to already reported WFD (Article 8) monitoring stations).

The reference will be done by means of a database. Spatial overlay of geographical datasets to link and analyse data will not always give the required results because of different data quality, level of detail and positional accuracy. Furthermore, problems might occur in handling of coordinates, reference systems and projections as well as during transformation of data. The exercise to locate WISE-SoE river monitoring stations to a European wide river dataset proved to be very troublesome. River monitoring stations are quite often located near the mouth of a river. To receive the correct location at the river overlaying point information (which is most of the time quite accurate) with a river dataset in the scale of 1:250.000 or even smaller will fail in many cases. Thus it will be necessary to refer monitoring stations to rivers in the dataset itself (attribute).

Relationships as regards case (a) mentioned above need to be defined in the data model. As regards case (b); Member States reported data should also include the identifier of the WISE objects as attribute (foreign key) either in the GIS dataset or in the table (e.g. Member States River Basin District (RBD) code and WISE RBD code).

Visualisation:

Data reported by Member States to WISE can be visualised either by:

- Displaying the Member States data regardless of whether data have been harmonized with neighboring countries or not, and regardless of whether or not data specifications developed for specific reporting have been taken into consideration (in this case Member States data will be marked accordingly);or

- Displaying the reference features and the harmonised data linked to them.

Example: Visualisation of river water bodies

In WFD Article 5 reporting, Member States were requested to provide information on the centroids of all water bodies. During this exercise, some Member States also provided information on river stretches. This has resulted in a variety of non-homogeneous information being provided (see Figure 6.3.1a): centroids-only, centroids & river network, and centroids and river stretches.

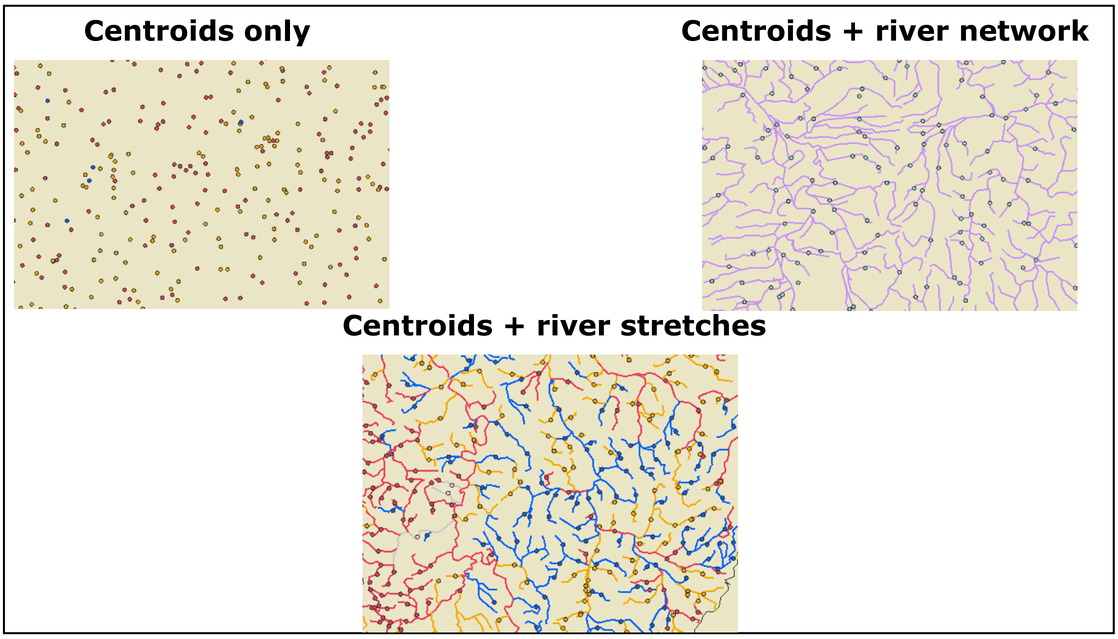


Figure 6.3.1a Information provided by Member States for visualisation of water bodies (WFD Art. 5 2005 submission)

Furthermore, Member States have used different methods to calculate the centroids of water bodies (see Figure 6.3.1b).

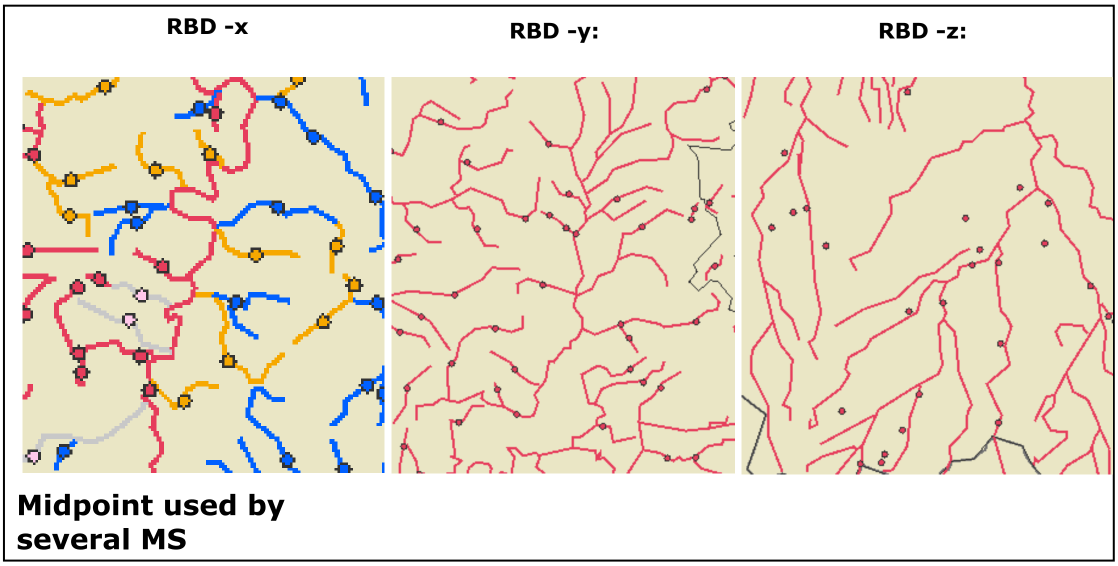


Figure 6.3.1b Representation of water body centroids provided by MS (WFD Art. 5 2005 submission)

This has resulted in an heterogeneous EU-wide dataset on 'water bodies'. To solve these problems it has been proposed to visualise river water bodies based on the WISE Reference GIS dataset Main Rivers. River water bodies located on Main Rivers should now be reported as hydrologically connected and harmonised river stretches (line features).[58] Thus a harmonised visualisation of reported data on river water bodies will be achieved in future.

Analysis:

Data and information reported to WISE will be used to present an EU-wide picture of water- related issues. The detailed information provided by Member States will be aggregated and visualised using meaningful spatial units at a European scale. To meet these demands, WISE reference features allowing comparable statistics and the development of indicators, have been defined (see Chapter 5.2).

As regards statistics, WISE reference features will be:

- Meaningful units to present information at a European scale (in relation to the aspired visualisation scale);
- Comparable depending on the specified statistical analysis and assessments.

Thus the definition of WISE reference features will also accommodate the purpose of use (e.g. compliance check; indicator development) and the required statistical analysis into consideration.

Example: River Basin Districts – Sub-units

Reporting under WFD is related to River Basin Districts. There was a general agreement that the portrayal of information at RBD scale is of value given the breadth of information associated with it. However, it was concluded that the use of the RBD scale alone could distort the comparison of data between Member States, due to the existence of a few RBD’s that are much larger than the rest (see Figure 6.3.1c).

There was agreement between the EC and Member States of the need to subdivide the larger RBDs to provide Sub-units of more similar size for better comparable analysis. A WISE reference GIS dataset of Sub-units will be developed (see Chapter 3.1) and in future, in addition to RBDs, data reported under the WFD should also be linked to Sub-units.

[58] Presentation at WISE conference on 22-23 March 2007: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_conventio/european_conference/presentations_speeches/part_4_23_march/deugenio-pdfpdf/_EN_1.0_&a=d

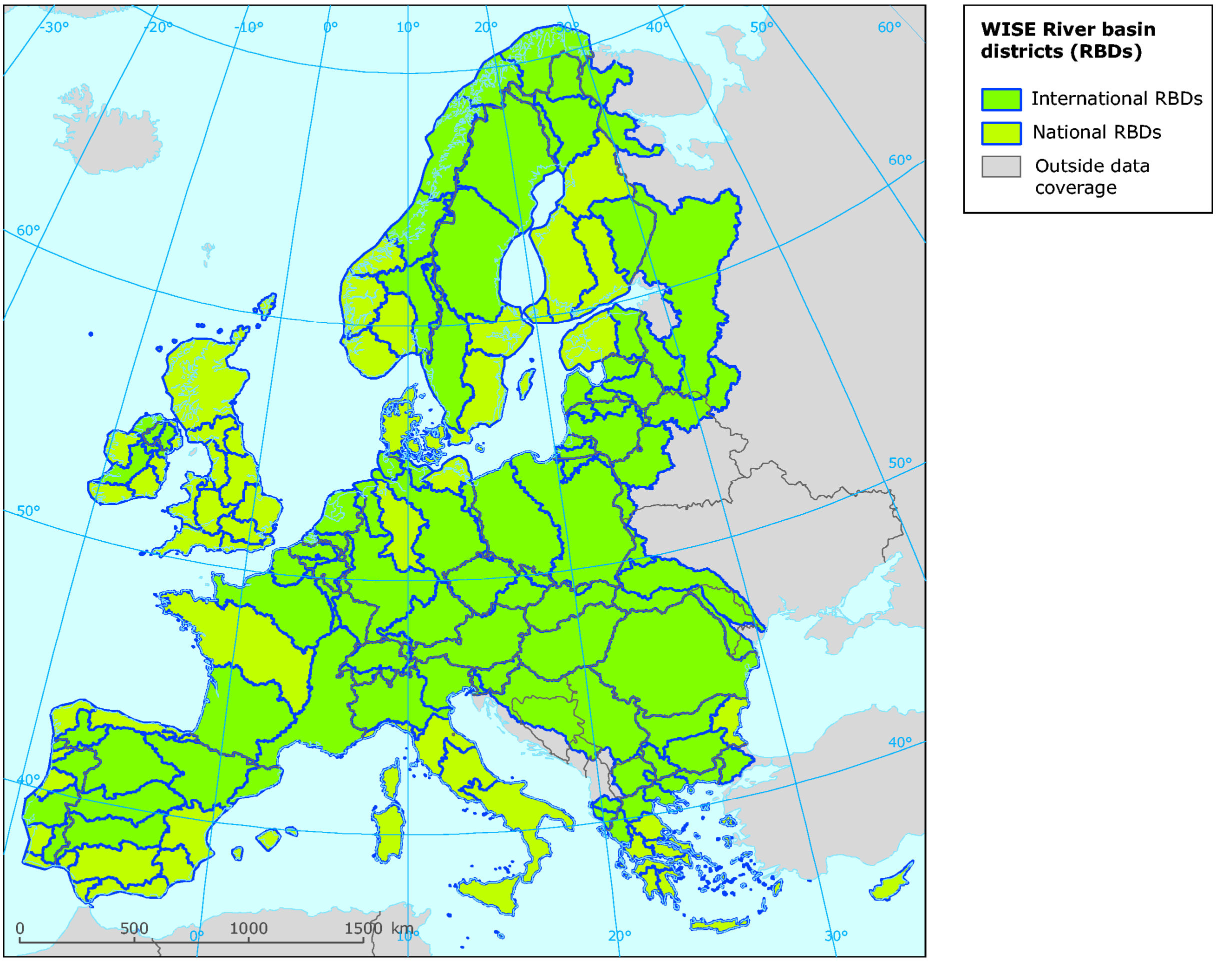


Figure 6.3.1c River Basin Districts[59] of the EU

6.3.2 Issues associated with WISE reference features

The main criterion for the use of reference features will be that they **should be built from Member States submitted data** to be able to visualise reported data correctly. Furthermore the positional accuracy and level of detail of the reference dataset should be in line with the required visualisation scale (for more details see Chapter 5.1.3).

If data provided by Member States are generalised to build reference features, the outcome of the generalisation must be validated by the data provider. This needs to be done to ensure the correct linkage between Member States data and reference features.

The guidelines for the development and use of reference features for visualisation are:

- **Definition of data use;**
    - Specification of the required visualisation of the data;
    - Specification of the required data analysis and/or indicator development.
- Specification of the **relationships between reference features and Member States reported datasets and objects**, needed to fulfill the intended use of data.

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[59] http://dataservice.eea.europa.eu/atlas/viewdata/viewpub.asp?id=3687

To define correct relationships, data specifications, especially data capturing rules (see Chapter 5.1), of provided data must be analysed. Relationships defined will also depend on the intended use of data (data analysis, indicator development).

For Example:

- All WFD reported information or datasets are linked to River Basin Districts/Sub-units;
- River monitoring stations are linked to river water bodies;
- River water bodies are linked to rivers.

  The above given relationship must be specified further before it can be transferred to a data model. In most cases, the relationship will be n:m (a river water body can be located at several rivers; a river will be composed of several water bodies). But this will only be true if river water bodies have been defined as river stretches (reaching from river km A to river km B). If they have been defined as polygons (catchments) the relationship could be different.

  Thus data capturing rules of river water bodies within Member States need to be analysed to be able to define the correct relationship between rivers and river water bodies.

- Development of **data models** supporting the specified relationships:
  - WFD objects reported should carry the WISE RBD code as foreign key;
  - River monitoring stations should carry the WISE river water body code as foreign key;
  - River monitoring stations located at Main Rivers should carry the hydrological code of the main river and the hydrological code of the river segment as foreign key;
  - **Unique identifier must be available for all relevant objects** (Member States data and reference features) and requirements given in Chapter 4.4 for identifier management must be taken into account (uniqueness, persistence). Furthermore to allow a persistent reference over time, rules for historic data management should be specified.

A description of the relevant WISE reference features and reference datasets (data specification, metadata) including the necessary details as mentioned above will be available in WISE.

6.3.3 Examples of WISE reference features for visualisation

Proposed WISE reference GIS datasets related to WFD reporting are described in Chapter 3.1 and an overview of the GIS layers in WISE is given in Chapter 5.2. In the following, text, some examples of reference features and their use will be provided. In future, further WISE Reference GIS datasets and reference features might be identified.

Main Rivers & Main Lakes:

The WISE Reference GIS dataset Main Rivers and Main Lakes contains rivers that have a catchment area > 500 km^2 and lakes that have a surface area ≥ 10 km^2. They are based on WFD Article 3, Article 5 submissions and when needed ERM (EuroRegionalMap) will been used to complement the layer. For more details about the datasets see Chapter 6.2. ERM data will be replaced by Member State data as soon as they become available.

Main Rivers and Main Lakes will be reference features for objects related to surface waters such as monitoring stations, bathing waters, waste water treatment plants. If desired, statistical analysis such as “number of river monitoring stations on a certain river” can be carried out.

The datasets will be related to the reference datasets on Surface Water Bodies on Main Rivers and Main Lakes (see below). Only surface water bodies located on Main Rivers will be visualised as river network in WISE.

Surface Water Bodies on Main Rivers & Main Lakes:

Surface water bodies on Main Rivers and Main Lakes will be the reference features to visualise surface water bodies reported by Member States as a connected river network (line feature) and lakes (polygon feature). They will be based on WFD Article 5 submissions of surface water bodies. A precondition to build this dataset will be that Member States report surface water bodies in future as line and polygon features and not as centroids (points) for this reference dataset. Furthermore the selection of the surface water bodies should be based on the rivers and lakes available in the WISE Reference GIS dataset “Main Rivers & Main Lakes”.

The reference features will be used to visualise information related to water bodies that are located at Main Rivers and Main Lakes like status information or heavily modified and artificial water bodies.

Furthermore, objects related to surface water bodies on Main Rivers and Main Lakes such as monitoring stations, bathing waters, waste water treatment plants can be visualised and analysed.

Groundwater Bodies:

The reference features Groundwater bodies will be based on WFD Article 5 submissions of Groundwater bodies. Groundwater bodies are transnational features and can also cross borders of River Basin Districts. Thus a harmonised European dataset will be developed including a unique European identifier.

River Basin Districts:

The reference feature River Basin Districts is based on the Member State submission under WFD Article 3. The data have been merged and harmonised to a European wide dataset. RBDs can be transnational features (international RBDs), thus a European unique identifier will be developed (see Chapter 5.4).

All data and information reported under the WFD is related to RBD. Thus RBD will be the main unit to analyse and visualise WFD data at the European scale. However, the issue of Sub-units needs to be considered.

Sub-units:

River Basin Districts are quite different in size. A few RBDs are much larger than the rest. Therefore it was agreed between EC and Member States to subdivide the larger RBDs to provide Europe-wide Sub-units of more comparable size which would be better suited for comparative analysis. It was agreed that the Sub-units should fall within national boundaries and be of a size between 5,000 and 50,000 km^2. This lower size limit does not mean that declared RBDs that are of a size less than 5,000 km^2 need to be redefined. Where RBDs exceed the threshold, the sub-basins or other suitable hydrological areas within the RBD could be defined as Sub-units.

In future, all data and information reported under the WFD should be related to Sub-units and/or RBDs . Thus in addition to RBDs, Sub-units will be the main units for analysis and visualisation of WFD data at the European scale.

Monitoring stations:

Monitoring stations will not be a WISE Reference GIS dataset as defined in Chapter 3.1. However, the monitoring stations of the WISE Reference GIS dataset reported under WFD Article 8 will be the reference feature to visualise various data related to monitoring stations. This should comprise all water-related monitoring stations (e.g. WISE-SoE monitoring stations or monitoring stations relevant for Nitrates Directive reporting should be subsets of the WISE Reference GIS dataset Monitoring stations). Thus data linked to monitoring stations can be reported in tabular form and linked to the information already available in WISE.

A precondition will be that monitoring stations must carry unique identifiers and, irrespective of the use of the station (SoE, WFD, BWD, NID, …), they will always be reported with the same unique identifier.

Note: *Monitoring stations or any other point information, for example agglomerations, urban waste water treatment plants, discharge points from urban waste water treatment, bathing water monitoring stations, etc. are the thematic layers that can be interlinked with the WISE Reference GIS datasets.*

Other WISE Reference GIS layers for other EU water policies, e.g. Sensitive Areas and their catchments for UWWTD, Nitrate Vulnerable Zones for NiD, etc. may be developed in the near future.

7 Coordination

7.1 Development phases of reporting cycle

The process on *what* to report is based on the legal requirements of EU water policy areas, and on the information needs of the European Parliament, other EU services and the European Commission's obligation to provide information for European Citizens.

The development of specific guidelines for the content and transmission of information of a particular reporting obligation follows a defined process under the Common Implementation Strategy (CIS) as seen in Figure 7.1.

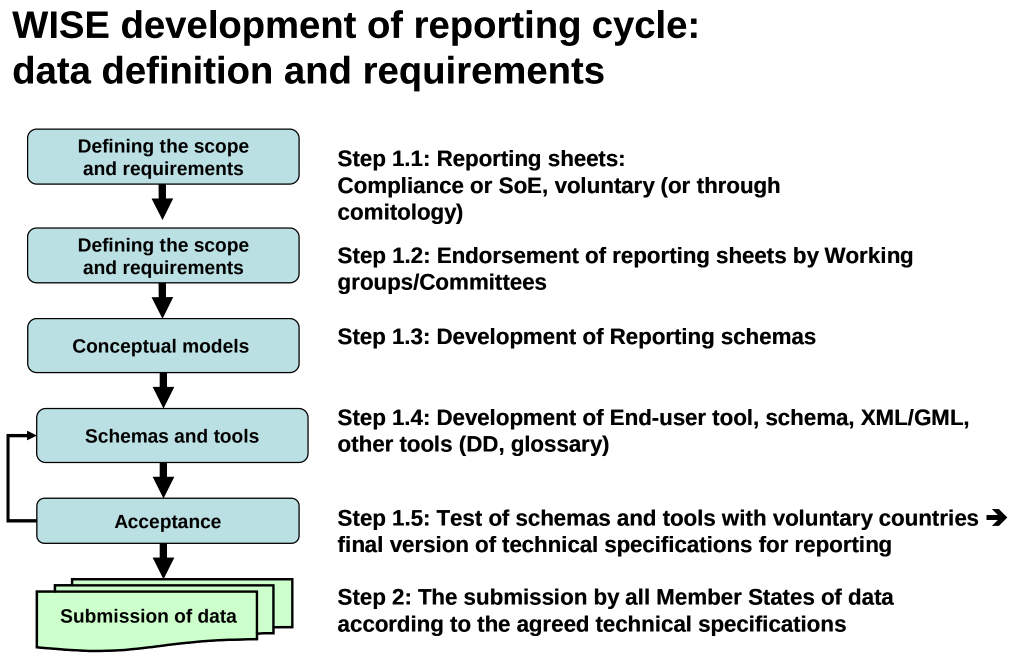

Figure 7.1 The development of specifications for a specific reporting obligation

In some cases, a Concept Paper on Reporting for a particular directive or an Article of a directive may be produced as a precursor to the Reporting sheets to allow the stakeholders to see and discuss the broader, strategic context of reporting before focussing on the more specific aspects of the Reporting Sheets.

Having the agreement on the contents and the form of reporting under each reporting exercise, technical implementation of reporting takes part.

Further steps of work flow and data flow via WISE is already presented in Chapter 1.2. The development cycle ideally starts 2-3 years in advance of the reporting deadline to allow Member States a timely implementation followed by the reporting.

7.2 Main coordinating groups

The central role of WISE development belongs to the WISE Steering group (WISE SG).

7.2.1 WISE Steering group

The WISE Steering group (WISE SG) is the main coordination body established at the EU level. It consists of representatives of four EU services (Group of 4: DG ENV, JRC, ESTAT and EEA) who guide the development of WISE. It ensures proper linkages with European Commission processes such as INSPIRE, SEIS and GMES. DG Environment chairs the WISE SG, holding meetings 2-3 times per year and external experts are invited as needed. The WISE SG reviews progress and plans upcoming work. It is also the forum to make connections to new and related work areas of WISE. WISE SG work is based on the WISE Implementation Plan agreed among the Group of 4 partners. On technical/IT matters, the WISE SG is supported by the WISE Technical group.

WISE Technical group

The WISE Technical group (WISE TG) assists on the development of the WISE system. It is chaired by EEA with representatives from DGs Environment , Eurostat and JRC, ETC-Water and a number of invited experts from Member States and external experts under support contracts. The WISE TG holds meetings 2-3 times per year and reports to and advises the WISE SG.

7.2.2 Water Directors, Committees, Strategic Coordination group and associated Working groups

Water Directors, Committees, Strategic Coordination Group (SCG) and associated working groups of relevant EU water policy areas[60] and other reporting activities at EU level[61] are the main consultation bodies involving Member States for issues related to the status of implementation of each water directive and other reporting exercises at EU level.

The Water Directors

Water Directors and the European Commission are steering the processes of the Common Implementation Strategy for the WFD which started in 2001. The group of Water Directors is an informal forum meeting twice a year under the auspices of the rotating EU Presidency. The main aim of the group is to ensure a coherent and harmonious implementation of EU water policy based on common understandings of the technical and scientific implications.

From the beginning it was realised that "*Most of the challenges and difficulties arising will inevitably be common to all Member States and many of the European river basins are shared, crossing administrative and territorial borders, where a* ***common understanding and approach*** *is crucial to successful and effective implementation. A Common Strategy could limit the risks of bad application of the Directive and subsequent dispute*".

[60] WG D on reporting and GIS for WFD, working groups on reporting for BWD, DWD, NiD, UWWTD, etc.
[61] Groups of national contact points for Eionet and water statistics under OECD/Eurostat Joint Questionnaire on Inland Waters.

The current progress and work programme[62], the 4th since the start of the CIS process, bears the main title "Improving the comparability and quality of the Water Framework Directive implementation."

Public documents on the implementation of WFD can be found at the EC document server[63].

The CIS model has recently been used when implementing the WISE Implementation Plan via streamlining reporting exercises and integrating all EU water policies and other reporting activities (such as SoE reporting, reporting on water statistics under the OECD/ESTAT joint questionnaire) into WISE.

Committees

The formal side of WISE development, as for example, endorsement of WISE reporting arrangements, reporting sheets/guidance documents, technical formats on reporting by each thematic area of water may be dealt with via Committees created for relevant EU water directives[64]. The Committees, based on the requirements of each water directive, are chaired by the Commission and have delegates from each Member State. The task of the Committee is to assist the Commission in guiding the implementation of water directives, primarily in an informal way, by endorsing documents produced jointly with Member States and relevant working groups through a common understanding.

Strategic Coordination group and Working group on Reporting

The Strategic Coordination Group (SCG) is an informal group mandated by the Water Directors. The SCG is chaired by the Commission and consists of delegates from Member State representatives and also includes NGO participation to ensure transparency and involvement of relevant stakeholders. The Working group on Reporting (WG D – Reporting) includes consideration of WISE and GIS and is one of 7 Working groups which function in the frame of the SCG and the Common Implementation Strategy.

As a basic principle of the CIS is to reach common understanding on reporting requirements, the relevant Working groups/expert forums on reporting for all water directives are actively involved in the WISE development process in the sense of discussing Reporting sheets and endorsing the process as such. The Working Groups are chaired by representatives from the Commission. The mandate and/or work programme is established and agreed by SCG (and endorsed by the Water Directors) for each Working group.

WISE GIS expert network

This network consists of experts in Information Systems and GIS nominated by the Member States. The network was formerly known as the "WFD GIS expert group" under the auspices of WG D. The network is invited, on an ad-hoc basis, to discuss

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[62] "Improving the comparability and quality of the Water Framework Directive implementation *Progress and work programme for 2007-2009"* available from http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents/strategy4pdf/_EN_1.0_&a=d

[63] http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive

[64] Art.21 Committee for WFD, art. 18 Committee of UWWTD, art.16 Committee for BWD, art.12 Committee for DWD, etc.

technical elements, in particular GIS and electronic reporting issues, regarding the development of WISE. In recent years in the frame of this initiative at least one workshop/seminar on WISE development has been held involving the water community concerned with reporting at EU level.

7.3 Involved organisations

7.3.1 Directorate-General Environment (DG ENV)

The main role of the European Commission's Environment Directorate-General (DG ENV) is to initiate and define new environmental legislation and to ensure that agreed measures are put into practice in the EU Member States. Its mission is protecting, preserving and improving the environment for present and future generations, and promoting sustainable development. DG ENV has overall responsibility for the WFD including the evaluation of Member State compliance with the directive. The responsibilities also include a number of proposals for specific measures and standards in various areas. DG ENV is responsible (under Article 18 of the WFD) for reporting the progress of implementation to the European Parliament and Council. DG ENV steers the process of integrating other EU water directives into WISE.

7.3.2 European Environment Agency (EEA)

The European Environment Agency (EEA) is an agency of the European Union. Its task is to provide sound, independent information on the environment and is a major information source for those involved in developing, adopting, implementing and evaluating environmental policy, and also the general public. Currently, the EEA has 32 member countries. The EEA's mandate is to help the Community and member countries make informed decisions about improving the environment, integrating environmental considerations into economic policies and moving towards sustainability, and to coordinate the European Environment Information and Observation Network (Eionet).

As a part of the “Technical Arrangement between DGs Environment, ESTAT and JRC and EEA on Environmental Data Centres” EEA has the role of the Data Centre for Water. EEA is responsible for the development of the WISE system and processing of data reported under WISE. EEA’s own thematic State of the Environment (SoE) reporting is incorporated into WISE.

7.3.3 DG Eurostat (ESTAT)

DG Eurostat is the Statistical Office of the European Communities. Its mission is to gather and analyse figures from the different European statistics offices in order to provide comparable and harmonised data to the European Institutions so they can define, implement and analyse Community policies. With regard to WISE, ESTAT is mainly involved regarding two roles. With the Eurostat/OECD joint questionnaire, ESTAT is taking an active part in European water data reporting which is intending to be streamlined with WISE. This also strengthens the cooperation on water quantity and emissions. GISCO, the Geographic Information System of the European Commission, is a service of Eurostat which promotes and stimulates the use of GIS within the European Statistical System and the Commission. It manages and disseminates the Geographical reference database of the Commission, acts as a reference centre concerning GIS, promotes geo-referencing of statistics and collaboration between national statistical institutes and mapping agencies, pursues and ensures standardisation and harmonisation in the exchange of Geographic Information, and co-leads the INSPIRE initiative on the introduction of a European Spatial Data Infrastructure.

7.3.4 DG Joint Research Centre (JRC)

The European Commission's Joint Research Centre (JRC) is a department (Directorate-General, DG) of the European Commission providing independent scientific and technological support for EU policy-making. It works closely on the development of EU legislation with the relevant Commission services. The Joint Research Centre has many roles related to WISE. JRC developed the WISE reporting prototype during the initial years of the WFD reporting and is now a user of the system in the frame of its environmental assessment and scenario modelling work. JRC also chaired the first WFD GIS Working Group and played a leading role in the preparation of the first WFD GIS Guidance document and contributes to the ongoing activities with expertise in the INSPIRE process. JRC is also active in several areas (e.g., flooding and drought) which could provide specific information to WISE. With the OECD/Eurostat Joint Questionnaire on Inland Waters, ESTAT is taking an active part in European water data reporting which will be streamlined with WISE. This also strengthens the cooperation on water quantity and emissions. GISCO as part of ESTAT is contributing with its experiences and services around GIS metadata and data.

Appendices

Appendices to the guidance are available on EEA CIRCA at: http://eea.eionet.europa.eu/Public/irc/eionet-circle/eionet-telematics/library?l=/technical_developments/wise_technical_group/updated_2nd-edition/appendices_updated&vm=detailed&sb=Title

Appendix 01: Elements of the WFD relevant to GIS

Appendix 02: WISE reporting arrangements

Appendix 03: Overview of maps available in the WISE map viewer

Appendix 04: Status of ISO / CEN standards relevant for WISE

Appendix 05: Table of GIS datasets and layers in WISE

Appendix 06: Data dictionary

Appendix 07: Proposal for a European coding system for hydrological features

Appendix 08: Testing the European coding system for hydrological features at selected rivers in the Danube River Basin District (available from March 2009)

Appendix 09: Management of identifiers and codes – proposals and examples

Appendix 10: SDIGER proposal for detailed specifications for metadata

Appendix 11: Implementation of the WISE metadata profile

Appendix 12: Example of GML structure and encoding

Appendix 13: Template for short GIS guidance for specific reporting

Appendix 14: Glossary of terms

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