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GEOGRAPHIC INFORMATION SYSTEM FOR THE DANUBE RIVER BASIN – SYSTEM DEFINITION

FINAL REPORT

WORKING FOR THE DANUBE AND ITS PEOPLE

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PREFACE

The long term goal of the Danube Regional Project (DRP) is, in short, to strengthen capacities of key Danube stakeholders and institutions to effectively and sustainably manage the Danube River Basin's water resources and ecosystems for citizens of Danube countries. This includes, developing and making available the key tools necessary for making effective management decisions.

It is increasingly recognized that one core tool for river basin management is a Geographical Information System (GIS). The main water policy driver in the DRB, the EU Water Framework Directive (WFD) underlines the need for EU member states and candidate countries to utilize GIS. The ICPDR is developing a Danube GIS, under guidance of the ICPDR GIS Expert Sub-Group, in order to use it for diverse tasks of the ICPDR, in particular for preparing a Danube River Basin Management Plan and fulfilling other EU WFD requirements.

The Danube Regional Project is supporting the ICPDR in the development of the Danube GIS through its Project Component on Development of the Danube River Basin GIS. After the 'needs assessment', carried out in the phase 1 of the DRP, the DRP is assisting with the design and implementation stage of the Danube GIS.

The Danube GIS is to be developed in a step-by step approach. Specific activities related to the System Definition, Design, System Building and Implementation are to be undertaken. The present report is a result of a first part of an assignment 'System Definition, Design and a First Prototype'. It provides development options, including anticipated costs and it will serve as a basis for the ICPDR to make decision about further development and implementation of the Danube GIS.

The report was prepared by a team of experts from Umwetbundesamt Wien (Federal Environmental Agency, Vienna), Ms. Ingrid Roder, Ms. Doris Riedl, Ms. Cordula Goke, Ms. Kerstin Placer and Mr. Michael Hadrbolec.

For further information about the Danube Regional Project, its objectives, activities, results etc. please visit the DRP webpage at: www.undp-drp.org .

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TABLE OF CONTENTS

ANNEXES

LIST OF TABLES

LIST OF PICTURES AND GRAPHS

ABBREVIATIONS

CCM	River and Catchment Database for Europe
COTS	Commercial off-the-shelf
DEM	Digital Elevation Model
DRB	Danube River Basin
DRB GIS	Danube River Basin Geographic Information System
DRP	Danube Regional Project
EG	Expert Group
EGM	EuroGlobalMap
EU	European Union
EU WFD	EU Water Framework Directive
GEF	Global Environment Facility
GIP	Geoinformation Product
GML	Geography Markup Language
ICPDR	International Commission for the Protection of the Danube River
JRC	Joint Research Centre
OGC	Open Geospatial Consortium
RBM EG	River Basin Management Expert Group of the ICPDR
RBM/GIS ESG	River Basin Management Cartography and GIS Expert Subgroup of the ICPDR
SLA	Service Level Agreement
UML	Unified Modeling Language
UNDP	United Nations Development Programme
WB	World Bank
WFS	Web Feature Service
WISA	Water Information System Austria
WMS	Web Mapping Service

1. INTRODUCTION

1.1. Background

One of the central elements of the **Water Framework Directive (WFD)** is the integrated approach within a river basin. This demands a profound master data set for retrieving adequate information on the current situation. The Water Framework Directive's success therefore crucially depends on the effort to co-operate beyond regional and national borders. This commitment to co-operation is all the greater if the tasks to be performed are made as transparent as possible and the respective responsibilities and competencies are specified precisely. The appropriate instrument for this is the **management plan** as defined in Article 13 of the Water Framework Directive. The management plan will be supported by appropriate tools, one of which is a Geographical Information System providing the means for a strategic decision support system for policy making.

1.2. Umweltbundesamt

The Umweltbundesamt was founded in 1985 by the Austrian Environmental Control Act and acquired the status of a limited liability company (ownership is represented by the Minister of Agriculture, Forestry, Environment and Water Management) in 1999. As the environmental expert authority of Austria's Federal Government, the Umweltbundesamt is working for and in close cooperation with the Austrian Federal Ministry of Agriculture, Environment, and Water Management, the European Environment Agency, and the European Commission, its key tasks being

- environmental control (state of the environment reporting)
- technical expertise and innovation
- support of law enforcement

The Umweltbundesamt employs specialists from all environmentally relevant disciplines to allow an integrative approach to environmental protection issues. The Agency has 360 staff members, about half of which have a university degree and are working predominantly in applied scientific research on environment-related issues.

The Umweltbundesamt is especially concerned with the WFD implementation on a national and international level and has therefore extensive experience in this field. As members of various bodies and working groups, our experts have been actively participating in the WFD implementation process since its earliest stages.

1.3. Water Framework Directive in Austria

The implementation of the WFD in Austria will be supported by **WISA,** the Water Information System Austria. On behalf of the Austrian Ministry for Agriculture, Forestry, Environment and Water Management, experts of the Umweltbundesamt and the Land-, forst- und wasserwirtschaftliche Rechenzentrum (LFRZ) are working on the system definition.

The project is subdivided into three modules: The **thematic and technology feasibility study** of WISA will be finished by the end of 2004; currently, our water management and IT experts are working on the **analysis study**, its principal aim being the definition of the required system functions and the master data input list. Although on a smaller scale, the requirements for the

WISA are comparable to those of a DRB GIS: The various datasets are maintained in the nine Austrian Federal States, at federal institutions and at the Umweltbundesamt. They have to be retrieved from the data providers and merged to provide a basis for the roof report. The WISA implementation phase will start shortly.

Table 1 Modules of the WISA project

Module 1	definition of objectives and as-is analysis, description of the nominal condition
Module 2	requirement specification, description of different options
Module 3	decision for preferred option, system specification, start implementation

2. TASK 1: OVERVIEW OF THE DESIRED SYSTEM

2.1. Objectives & overview of the system

The system definition process is vital for obtaining a **short list of suitable options** for the implementation of a Danube River Basin GIS that will satisfy the **involved users' needs**[1]. Existing documents, reports and questionnaires concerning the current status of GIS and geodata in the Danube River Basin were therefore taken into account and the existing infrastructure considered. The DRB GIS described in this report is based mainly on the requirements expressed in documents and statements of the RBM EG and the RBM GIS ESG; other Expert Groups' demands might be included for further adaptation of the system. Once the **general system architecture** has been approved by the institutions involved and the initial system is operational, the **system environment** can be further tuned and adjusted to fit specific (further) user requirements.

As defined in the "Strategic Plan for the development of the Danube River Basin GIS"[2], the system will primarily be a platform for exchanging geo-information and related issues. The vision outlines the intention of a DRB GIS to become a tool for reporting, management, and planning, while its system architecture remains as flexible as possible to be able to meet future needs. The system requirements can be broken down into the following issues, the main objectives of the system architecture thus being:

> support WFD reporting and map making

> integration of **existing and future information data sources** (e.g. Danubis) to increase usage effectiveness

> optimisation of **costs**

> anticipate **analysis and modelling functionality** for future system expansion and take this into consideration in the system definition and design phase. These functions will, however, not be conceived as a priority component of the DRB GIS now

The starting point for the implementation of a DRB GIS as described in the Strategic Plan (p. 9: Technology and Implementation Plan) is the development of a centralised DRB Web GIS (2nd phase in the Strategic Plan). This centralised Web GIS will, however, already anticipate its future enhancement towards a decentralised system architecture.

Table 2: System architecture options as described in the Strategic Plan

	System architecture	**Storage**	**Quality assurance**	**Access**
2nd phase 2005-2008	centralised system	one database incl. all datasets	implementation based on one validation mechanism	one gateway
3rd phase 2008 -.....	decentralized DRB WebGIS	distributed data providers	implementation of validation per data provider	standards and protocols

The two options for the system architecture of a DRB GIS as described in the Strategic Plan are summarized in Table 2. Following this paper, the implementation of a centralised system that

[1] Towards a Danube River Basin GIS: Needs Assessment and Conceptual Design for a Danube River Basin GIS System, Final Draft, KTH, Department of Land and Water Resources Engineering, Stockholm, 2003.

[2] Strategic Plan for the development of the DANUBE RIVER BASIN GIS, Zagreb, 16.02.2004.

can later be modified to function as a data node in a future decentralised system is planned for now (Figure 1).

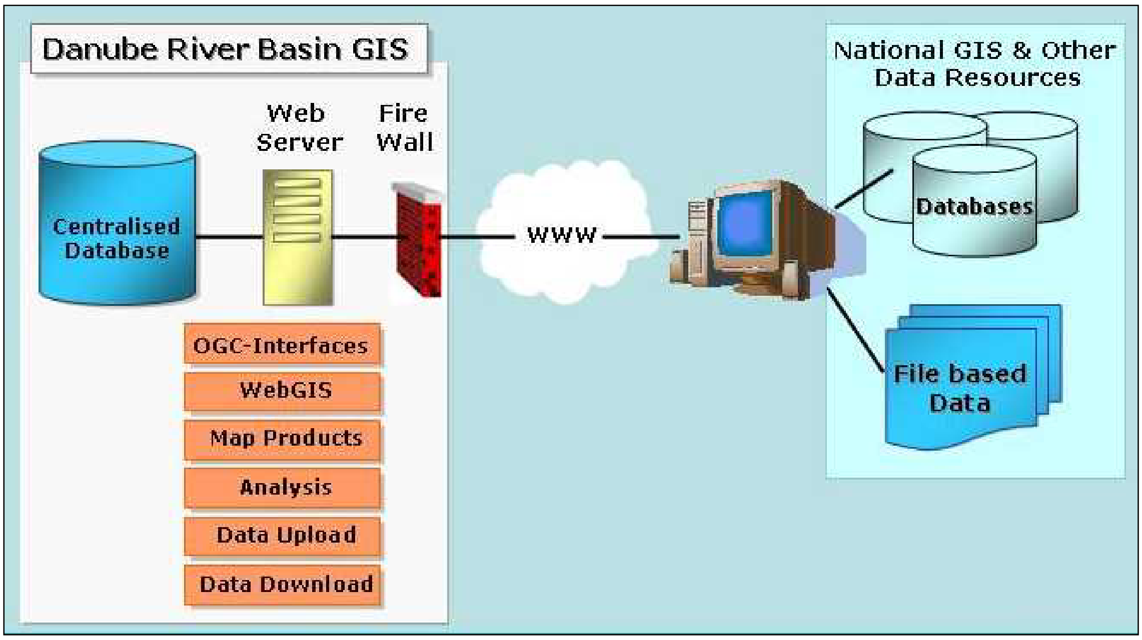

Figure 1: System architecture: Centralised system

A **centralised system** provides one single database with harmonised datasets. These datasets can be queried and viewed with the same mechanism because one data model within one single database management system is used. Quality assurance checks can be implemented more easily because they are part of the underlying system's software. Access is provided in a specified way that may be a proprietary **industry solution** (e.g. ESRI) and/or an **OGC-compliant system** (Web Feature Service, GML etc.). The advantage of this kind of system as opposed to a decentralised system architecture is that it can be **implemented faster and easier**. Therefore, this system architecture will be implemented in the first stage of a DRB GIS.

In further years of usage, however, the enhancement of the centralised system towards a distributed and decentralised system should take place. The initial centralised system can then function as a special data node with aggregation functionality.

A **decentralised system** will provide access to distributed databases via the Internet. Aggregated information (e.g. necessary for the roof report) can only be retrieved if every database provides the implemented interfaces and these are permanently available online. Querying, download, upload and error checking should be made possible via **OGC** (Open Geospatial Consortium)**-Interfaces**.

The advantage of this option is that the transfer of data is reduced to a minimum. The main task here is to **define and setup the system**. During the follow-up years, the effort required for maintaining several databases, web mapping services, web feature services and web servers should not be underestimated. Thus, we plan to already implement OGC-Interfaces in the DRB GIS as it will be developed now, so as to provide experience in the implementation for the second phase.

As for the system configuration, the mandate for this report was to describe three alternatives for system implementation: a system option based on commercial software products, an open-source alternative and a mixed version. Both open source and commercial software-based systems have their assets and drawbacks; cost-wise the difference is smaller than might be expected: while commercial software products trigger licence fees, open source products require more programming and maintenance effort.

2.2. System scope and system restraints

Basically, the DRB GIS will be a web-based tool for collecting, storing and viewing/querying harmonized geodata for the Danube River Basin. GIS users from the Danube riparian countries can upload their data to the central server via web interfaces and make use of the tools and processes to harmonize the data to create a common Danube River Basin database. While the data owners keep all rights on their data, they can – if they decide so – grant other parties the rights e.g. for downloading the data via the respective tool provided. Experts can use the WebGIS to view the data, run queries and extract information in the form of tables, diagrams or working maps. A generalized WebGIS with restricted functionality is available for the general public, i.e. users unacquainted with GIS and the technical aspects of water management issues.

While the DRB GIS provides a wide range of GIS functionalities and geodata viewing possibilities, it cannot replace any national GIS system. Some of the classical GIS functions like for example extensive spatial analyses remain in the hand of desktop GIS users - it would simply not make sense to conduct such processes via a web application. In countries where no national GIS exists, however, the DRB GIS might well be considered to be a starting point for the development of such a system.

The DRB GIS cannot by itself produce high-quality paper maps in the sense of a cartographic product. Such maps require individual composition according to scale, data quality and purpose; an automated system can not replace the cartographer.

The integration of the DANUBIS web portal is recognized as an important issue for the DRB GIS. However, extensive changes and technical reorganisations are planned for DANUBIS in the near future. As long as it is not clear what technology DANUBIS will be based on in the future, its integration into the DRB GIS can not be planned in detail.

One of the main constraints the DRB GIS might have to suffer from (at least in the beginning) is lack of (adequate) data. Having said that, it is important to note that at the same time, the DRB GIS provides indispensable support in this matter. By giving a clear picture of what is already available, what is still missing and what might need improvement, the status of Danube River Basin data can be monitored, described and thus enhanced much more efficiently.

The most obvious question concerning the necessity of a DRB GIS is what its benefits in comparison to the current situation are. Map production for Roof Report 2004 has been accomplished without any DRB GIS, so what are the advantages of the creation of a web-based system?

> The DRB GIS facilitates the consolidation of data from different sources in one database, where consistent data structure and standardized access to the data is guaranteed. Without the DRB GIS, the development of a collective Danube database will be hardly possible.
> A DRB GIS comprising all data available allows a sound evaluation of completeness, consistency and accuracy of the data. It gives an overview of what is there in what quality and shows where improvements are required. Duplicate data and inconsistencies may be avoided.
> In a common database, quality assurance measures can be applied comprehensibly and much more effectively. Data quality thus can be monitored and documented in a

straightforward manner that is indispensable especially in the first stages of the compilation of a common Danube database.

> The objective of a common Danube database is not only the collection of data from the whole Danube River Basin, but also their harmonization. While the DRB GIS can still not give any guarantee that this goal will be reached, the implementation of tools supporting the aim and the definition of fixed procedures substantially assists the purpose.

> Not only the data, but most importantly also their metadata will be available in the DRB GIS system. These include information like for example who is responsible for the data, whether there are any constraints for data usage or the data's reference system.

> Contrary to any paper map, the DRB GIS can provide more than just visual information. While a map can only just show a limited amount of information, a WebGIS allows querying all information related to any spatial object. For example, river name, length, catchment size etc. can be gathered by just one mouse click, while it would require several paper maps to make that information available. Querying functions give access to the whole database that lies "behind" the data visible on the map and also shows the relationship between different data in the database (e.g. show all contaminated sites within a certain area in the map and as table).

> While a paper map is composed for a single topic and in a fixed scale, the WebGIS functionalities of the DRB GIS allow much more flexible data viewing. Web maps are created dynamically and allow the user for example to display different layers, zoom in and view data details that are not visible in small-scale paper maps or search for features on the map by their name or value.

> The non-existence of a DRB GIS system bears the risk that every time maps have to be produced, this is accomplished afresh and with duplicate effort and thus expense. The DRB GIS guarantees continuity by integrating all maps and data that have already been created.

> The DRB GIS is not only a tool for data input, but data can also be retrieved from the system by all users who are granted the respective rights. The data owners retain full control of their data, but can allow other DRB GIS users to utilize them. Currently, no defined data exchange is possible, only maps in graphic format are commonly available.

> With one system, different user needs can be satisfied. With its different levels of functionality tailored to the degree of expertise the various user groups exhibit (e.g. general public to WFD- or GIS-experts), the DRB GIS will be usable for a large target group.

> By enabling the general public to view Danube data via the public WebGIS, the DRB GIS fulfils the WFD requirement of public information dissemination.

> The DRB GIS does not only provide data and supporting information for WFD purposes, but can easily be extended to assist further reporting obligations.

2.3. System measures

While some factors crucial for the success of a DRB GIS lie outside the system scope and thus cannot be used for evaluation of the system itself (e.g. availability of adequate data), the following aspects usually are reviewed for assessing system success[3]:

> functionality
> performance
> reliability

The system's **functionality** indicates whether it can perform the functions necessary to create the information products required. **Performance** refers to the fact that this can be accomplished in a timely manner under normal operating conditions, and **reliability** denominates the system's availability and recovery, i.e. the minimisation of down-time. To this we would like to add the factor **usability**, i.e. the creation of an easy-to-use, mostly self-explaining system. The reliability of the system is determined by the conditions established in **Service Level Agreements** that should be concluded on system implementation.

The DRB GIS should represent a usable system that is appropriate for its purpose, fulfils the requirements and is extendable for future expansion, and exhibits a high level of usability. By satisfying these criteria, the system should generate a high level of **user satisfaction**, which will be taken as yet another means of measuring the system's success.

2.4. Quality assurance

Quality assurance is a crucial point in the development of a DRB GIS. To be able to guarantee the development of a high-quality product, the system's components as well as its content will undergo extensive quality assessment procedures. Wherever applicable, we will hereby follow the relevant ISO standards[4]. It is important to note, however, that our commitment to the relevant ISO Standards does not imply any obligations (e.g. concerning data quality principles and procedures) for the Member States. An inquiry carried out by EuroGeographics in 2004 shows, however, that the ISO 19100 standards are already used in several of the DRB GIS member states' NMCAs (compare www.eurogeographics.org/eng/documents/Report_ISO_final.doc (31. 1. 2005)).

The quality assurance process is a continuous one throughout the DRB GIS development and implementation process, beginning with the definition of system measures and quality indicators, continuing with formalised control mechanisms and culminating in the assessment of the achievement of objectives and – if required – the necessary modifications. As for data quality, automated checks built into the system on the one hand and the clear definition of procedures and responsibilities for error correction on the other hand will support the optimization of the data input to the DRB GIS. A description of the quality assurance measures taken and a presentation of the results will be delivered in recurrent reports throughout the course of the project.

[3] Reference: Longley P A, Goodchild M F, Maguire D J, and Rhind D W (eds). 1999. Geographical *Information Systems: Principles, techniques, management and applications.* New York: John Wiley.

[4] ISO 19113: Geographic Information – Quality principles, ISO 19114: Geographic Information: Quality information procedures

The **quality objectives for the system components and system functions** include the following aspects:

> **availability** vs. down time (e.g.24hours/7days or 8 hours per day for 5 days/week)
> **usability**: self explaining user interfaces with minimum training effort and a help system will be available. An integrated help system enables users' self-help. A tutorial for first usage will be included
> **performance tests** of server architecture, software, database, dynamic web pages, coding of system function ☐ benchmarking
> **system updates (**e.g. security updates for operating system)
> **automated maintenance routines** to guarantee optimal system performance
> **training:** extensive training for DRB GIS users will be provided
> **user satisfaction:** to guarantee the user's satisfaction with the final product, we will take care to incorporate continuous user input in all project phases (compare chapter 2.5 "Methodology")

As for the system maintenance, a high level of quality will be guaranteed by a **Service Level Agreement (SLA)** that determines which maintenance services are provided by an operational DRB GIS. Maintenance costs will depend on the specifications in this agreement. The system defined by the Umweltbundesamt does definitely not necessarily have to be implemented at the Umweltbundesamt, but can be run in any place.

Data quality will be assured in a manifold manner; predefined workflows for data handling arrange for an effective way of dealing with data and continuous quality control. Firstly, data are examined for their conformity to quality elements and to the standards defined: During data upload by the data input user, automated quality checks (e.g. concerning attribute conformity and the existence/completeness of metadata) will be performed. A feedback message will then be generated and sent to the data input user. Secondly, as for data harmonization, reconcile users will be responsible for checking the data's seamless matching at country borders. Once this step has been taken, the decision maker as final authority for the national data sets can officially release the data (compare chapter 4 "Task 3: Master Input Data List").

2.5. Methodology

Taking the project's framework and the given organizational structures into account, we consider an iterative approach most appropriate for the development of a DRB GIS. In this methodological framework, the progress of work will regularly be presented to future users and the institutions involved. Input from these groups will then be used to continue and further refine our work, so that the final product fully matches the user's requirements. User input will be obtained in regular meetings or alternatively via requests for comments by e-mail or in an online discussion forum (as already existing in Danubis). As the reports to be delivered, meetings and other input requests constitute points of time when user feedback is being included in the project, each of these dates represents the finalization of one iteration in the project process.

Figure 2: GIS methodology

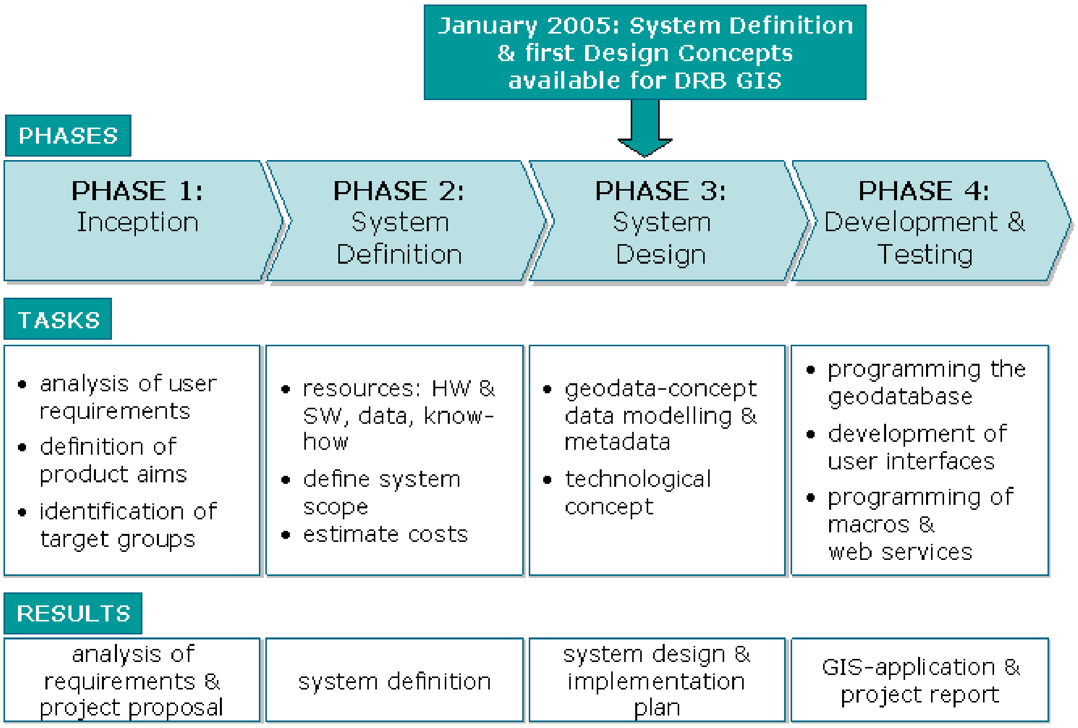

Figure 2 gives an overview of our methodological framework, showing the basic phases a GIS project should undergo in a linear manner. For the DRB GIS, the completion of the Final Report marks the end of Phase 2, the System Definition Phase. In every phase, recurrent cycles of reporting to and feedback from future users are added to support our user-oriented approach. In that way, our methodology reflects the approach taken e.g. by the Rational Unified Process (see Figure 3). We will, however, not commit ourselves to a proprietary software package for methodological planning.

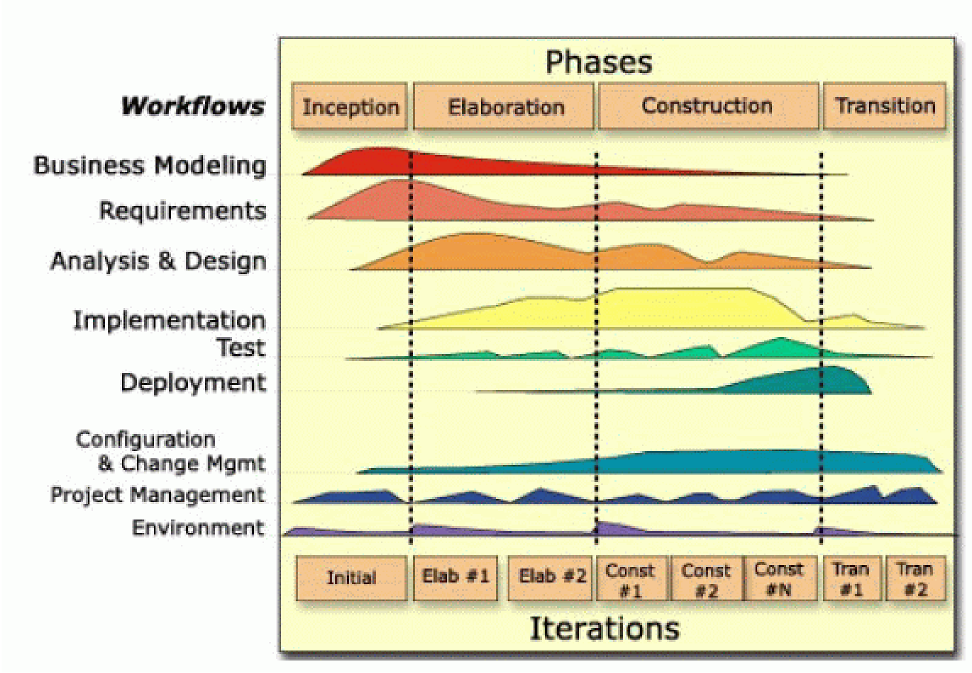

Figure 3: Example for iterative planning[5]

As for the planning process itself, we took Roger Tomlinson's benchmark "Thinking about GIS"6 as a reference and guideline. Tomlinson identifies the planning of the desired information products, the data needed and the consequential hard- and software requirements as well as the definition of procedures as the essential components that need to be defined in a GIS planning process (Tomlinson 2003: 7f.). The structure of this report orients itself on the planning steps advised in Tomlinson's work.

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[5] Source: http://www-106.ibm.com/developerworks/rational/library/content/RationalEdge/jan01/WhatIstheRationalUnifiedProcessJan01.pdf (31. 1. 2005)

[6] Tomlinson, Roger. 2003. *Planning for a GIS: Geographic Information System Planning for Managers.* Redlands, Calif.: ESRI Press.

3. TASK 2: GEO-INFORMATION PRODUCTS

3.1. Geo-Information product types

The important first step in the definition of a GIS system is the exemplification of what the system should be able to deliver – the geoinformation products. Further on, the list of geoinformation products **(GIP)** forms the basis for the creation of the Master Input Data List (compare chapter 4 "Task 3: Master Input Data List"). To give a structured overview of the relationship between geoinformation products and data, an ER-model has been created (Figure 4). The different tables shown in the model will be explained in the following chapters. The link_...tables that build the one-to-many relationships between different tables will be provided in digital form only.

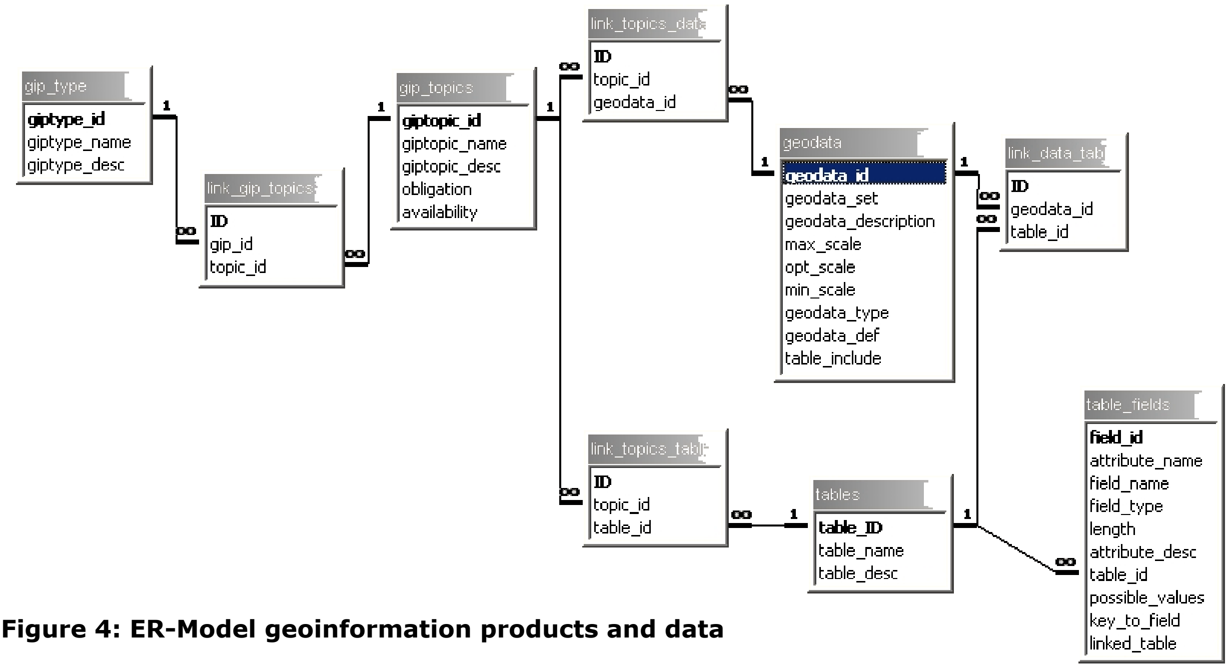

Figure 4: ER-Model geoinformation products and data

The list of products from the DRB GIS contains the following geoinformation product types.

Table 3: GIP types

gip_type		
giptype_id	**giptype_name**	**giptype_desc**
1	map	Cartographic maps in PDF-format
2	webmap	Map created via WebGIS for on-screen display with print/export option
3	table	Information table (with available links to geographic object)
4	query	Query string
5	diagram	Diagram
6	statistics	Statistic tables for data

3.1.1. Maps and Webmaps

One of the principle functionalities of a WebGIS is the production of interactive maps. Apart from viewing the maps on-screen, the system will provide the possibility for users to print the maps they generated or save them (in PDF of graphic format) on their own hard-disk. For that purpose, there will be templates for maps to be printed out from the WebGIS. That is, the user chooses from the list of layers he/she wants to be included in the map. The result of this action plus the choice of the style (page size and orientation) will constitute the final map.

Furthermore, a style guide for Danube maps will be defined. This style guide can either be composed of map templates users can download and use directly in their GIS or of picture graphics. For either possibilities, a proposal will be made for the character set to be used in the maps and for the placement of the different map elements (title, scale bar, source, ...), which has to be based on cartographic principles.

The maps that can be created in the DRB GIS can serve for working purposes only. Since there will not be any interaction with a cartographer during map creation, the system can only give guidelines for map production rather than delivering a finished high-quality map product.

Apart from the possibilities of the production of working maps, all already finished map-products (like the maps for the Roof Report 2004 and others disposable in Danubis) will be made available for download or print-out via the system. Since these map products will be subject to updates and by 2006 further WFD reporting maps concerning "monitoring" will follow, the Umweltbundesamt can, if required, offer an extra item (outside of the DRB GIS System) of cartographic work on WFD reporting maps.

3.1.2. Tables and Query Strings

Tables as an extract of the DRB GIS databases can be either displayed on screen or exported to a file (e.g. XML or XLS). The DRB GIS user can choose out of a list of data themes and their attributes. The output of this action can be amended by queries.

A list of predefined queries will be available for standard table outputs (e.g. for the public user). The expert user can store his/her advanced query strings. However, there will be no final query tables stored in the system - the tables will be created on the fly based on the data in the system.

3.1.3. Diagrams

Charts will be created directly from the data stored in the GIS system. The expert user can choose out of a list of data themes and their attributes and create a chart based on a chart template (e.g. bar chart, pie chart, ...). The chart can be exported to a graphic format.

The public user can choose a chart out of an assortment of choices and the chart will be created based on standard queries (comparable to the creation of public user tables).

3.1.4. Statistics

Statistics will form a special sort of secondary tables that will give overview information of the features included in the datasets (amount of features in a dataset, mean values …).

3.2. Geoinformation product topics

While the geoinformation product types state the nature of the products the system will deliver, the geoinformation product topics show the thematic information available in a specific geoinformation product. As for now, there are 18 GIP topics available for which the gip_type is defined via a link table. It is suggested to use the gip_type "map" and "webmap" for all of the WFD reporting geoinformation product topics and the type "webmap" for the remaining ones.

Table 4: GIP topics

gip_topics				
giptopic_id	**giptopic_name**	**giptopic_desc**	**obligation**	**availability**
1	RBD overview	Danube river basin district overview	WFD	2003
2	Competent authorities	Competent authorities	WFD	2003
3	Surface water bodies - categories	Categories of surface water bodies	WFD	2004
4	Surface water bodies - types	Types of surface water bodies	WFD	2004
5	Groundwater bodies	Groundwater bodies	WFD	2004
6	Monitoring network for surface water bodies	Monitoring network for surface water bodies	WFD	2006
7	Ecological status and ecological potential of surface water bodies	Ecological status and ecological potential of surface water bodies	WFD	2009
8	Chemical status of surface water bodies	Chemical status of surface water bodies	WFD	2009
9	Groundwater status	Groundwater status	WFD	2009
10	Groundwater monitoring network	Groundwater monitoring network	WFD	2006
11	Protected areas	Protected areas	WFD	2004
12	Status of protected areas	Status of protected areas	WFD	2009
13	Topography	Topographic description of the DRBD		
14	Geology	Geologic description of the DRBD		
15	Precipitation	Precipitation regions		
16	Landuse	Landuse categories of the DRBD		

For each of the topics a list of geodata and/or data is defined (a link-table combines the gip_topics with the geodata). Geodata is described in chapter 4 (Task 3: Master Input Data List) and shown in Annex A, Table 1.

4. TASK 3: MASTER INPUT DATA LIST

Data in the DRB GIS will be used for different purposes, the most important being the following[7]:

> River Basin Management (RBM) within the ICPDR
> EU Water Framework Directive support for reporting
> Strategic decision-making
> Public information dissemination

The fact that the DRB GIS will be used for different purposes leads to the differentiation of several data user groups with varying user rights (see use cases shown in chapters 5.2 f.) Many data sets entered in the geodata list (see Annex A, Table 1) have already been created for the first WFD roof report 2004, but they have to be consolidated to be easily accessible and to be ready for use in a DRB GIS. The data that is available now forms the basis for maps printed in a scale 1 : 4,500.000. To suffice the WFD requirements of representing areas with the minimum size of 0.5 km2 (lakes) or river catchments sized 10 km2 and larger (relating to the whole river length) this scale will not be enough and can therefore only serve for overview maps. Following the cartographic rule of minimum dimensions, a feature presented as coloured area should not be smaller than 1 mm2 (because if smaller, it can not be seen anymore without additional visual devices). This means that data of a scale of about 1 : 700.000 is required if lakes should be shown as coloured areas. If a more sophisticated presentation is desired, like for example lakes with coloured lake area and differently coloured lake boundaries, and/or some more feature detail should be presented, a finer scale of about 1 : 300.000 or - as the GIS Working Group suggests - 1 : 250.000 would have to be achieved. Since it is not at all realistic that there will be a common dataset 1 : 250.000 in the near future (in the next 3 years) for all of the Danube River Basin, the DRB GIS has to follow a very pragmatic approach and create a dataset that can be used in the meantime, while the data list is kept open for future enlargement and enhancement.

Some of the data used for the maps in the roof report maps is already based on detailed scales (from 1 : 50.000 downwards), but the detail provided in this scales cannot be used because the data comes from different sources and therefore the topological consistency is too poor to allow a zoom in on the original scale. The example shown in Figure 5 illustrates the topological incoherence between two data layers (red: boundaries, blue: rivers, which should lie on top of each other) of the existing data sets. These data lack vertical harmonization (compare chapter 4.1 "Data Harmonization").

[7] Strategic Plan for the development of the DANUBE RIVER BASIN GIS, Zagreb, 16.02.2004

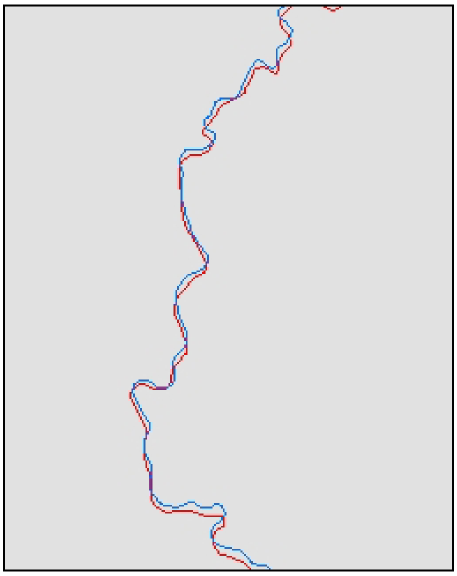

Figure 5: Topological incoherence of data at the Austrian/Slovakian border

In the DRB GIS needs assessment[8] a three stages scenario with a short, a medium and a long term view has been drafted. Data-wise, these scenarios can be "translated" into three different eras for the DRB GIS: the short time view represents the pre-DRB GIS era. The medium time frame must be seen as an era of pragmatic work, which means that (basic) data available have to be adjusted as good as possible, but going for best quality. The pragmatic era also is the period when standards have to be set and data models have to be fully developed. The long term time frame can be called the enhancement era and will allow substituting inferior data with higher quality data.

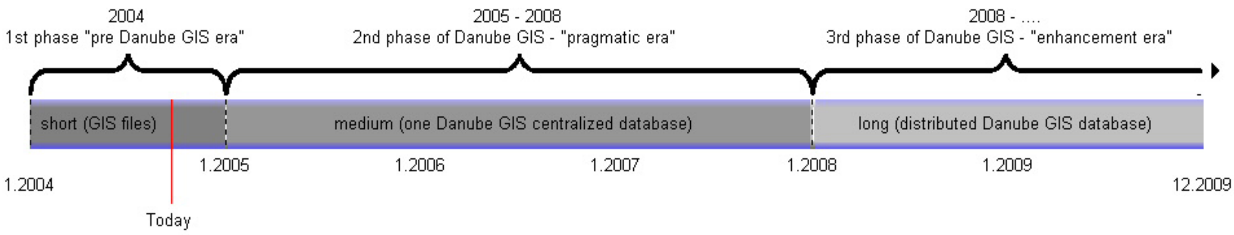

Figure 6. Timeline for data preparation

[8] „Towards a Danube River Basin GIS: Needs Assessment and Conceptual Design for the Danube River Basin GIS System", KTH, Department of Land and Water Resources Engineering, Stockholm, 2003.

4.1. Data harmonisation

Data harmonisation is an imperative for obtaining a functioning common DRB GIS. It has to be carried out on at least two levels:

1. Harmonisation as regards data content
   > Attribution of data
   > Metadata
2. Harmonisation of the geometry
   > Horizontal level: neighbouring states must fit together in each of the data sets
   > Vertical level: different layers must fit together

4.1.1. Accomplishment of harmonization

The centralised administrator or a centralised contractor of the DRB GIS will contribute to the harmonisation process, but it will not be possible to carry out the total amount of harmonisation work necessary.

<u>Why is it not possible for the DRB GIS administrator/contractor to do data harmonisation</u>?

Because it is mainly a semantic task, the **harmonisation regarding data content** has to be carried out in the appropriate committee. For example, several classifications for river types are in use in the Danube River Basin's countries. The harmonisation of river types should lead to a concerted code list of river types.

The **harmonisation of geometry** has to be carried out on the basis of bilateral agreements/cooperations of the Danube River Basin states. It is not possible for one centralised user to intervene with national data, because there is no mandate for such an intervention.

<u>Contributions of the DRB GIS administrator/contractor to data harmonisation</u>

Templates for attributes will be provided for every thematic layer. For any differences between national naming and DRB GIS naming of attributes, a **schema mapping** tool for the translation of the national attribute name to the DRB GIS attribute name will be provided.

For future extensions of the DRB GIS a **code-translator** for the matching of codes could be established. This code translator would list both of the codes of the National and the DRB GIS for one dataset. The national expert would then establish links between matching codes via drag and drop. Afterwards a translator table would be created (could be saved) which serves for calculating new values during the data import to DRB GIS.

4.1.2. Geometry framework

To obtain a common geometry, the adoption of common standards (e.g. common geodetic reference system for DRB GIS data, approved positional accuracy) will be the basis, but this will not be enough. For the positional data fitting, which as pointed out above mainly is a bilateral national task, a DRB GIS framework of steps to be fulfilled will finally lead to a seamless data set. The quality principles of ISO 19113[9] should - as far as possible - be applied to this framework and the framework will be close to the WFD GIS Guidance Document[10].

The following table shows the steps to reach a geometry framework and a common geometry for all datasets in the DRB GIS. Step 1 through 9 will create the framework, in steps 9 and 10 data are fitted into it. For 9 and 10 data input procedures check the data when uploaded to the DRB GIS (e.g. no data outside the national boundaries) and report errors to data input users (compare chapter 5.3 "Data handling functions & conversion requirements")

Table 5: Harmonisation steps

Steps		2nd phase – pragmatic	3rd phase – enhancement
1	Agree on common data quality for reporting	EGM data quality - the tolerance for connection at borders and the related accuracy should be better or equal to 1/10 of the accuracy of the EGM dataset	ERM data quality - the tolerance for connection at borders and the related accuracy should be better or equal to 1/10 of the accuracy of the ERM dataset
2	Agree on state boundaries between the DRB states	National Task*: It is of high importance that the boundary between every pair or neighbouring states will be officially approved. The approved state boundaries have to be delivered to the DRB GIS.	
3	Harmonise and adopt a coastline	National task* for states situated at a marine coast The coastline has to be delivered to the DRB GIS	
4	Combine harmonised coastlines and create a landmass/sea data set	DRB GIS Task (contractor)**: The delivered coastlines must be put together and combined with an widely available landmass/sea dataset (maybe at less detail) to form one of the base datasets for DRB GIS	
5	Harmonise the boundaries of the Danube river basin district	National task* - fulfilled Control and rework may be necessary	National task*
6	Harmonise the boundaries of the river basins	National task* - fulfilled Control and rework may be necessary	National task*

9 ISO 19113: Geographic Information – Quality principles

10 Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance Document No 9 Implementing the Geographical Information System Elements (GIS) of the Water Framework Directive. Produced by Working Group 3.1 – GIS

Steps		2nd phase – pragmatic	3rd phase – enhancement
7	Harmonise the transnational river network (RWseg) and lakes (LWseg) – Do so in steps: Danube Rivers with catchment greater than 4000 km² Large Lakes Rivers with catchment greater than 1000 km² Rivers with catchment greater than 500 km² Small Lakes Small Rivers	National task*	
8	*Working Areas*[11]	*National task**	
9	Prepare other datasets	National task* All other data sets have to be prepared by each state based on the agreed state boundary and in topological coherence with the harmonised boundaries of the states, coastlines, river basin district, the river basins, the working areas[11] and the river network	
10	Base data sets	DRB GIS Task (contractor)**: Bring commonly available data sets (e.g. DEM, CORINE, Climate data, …) in the same geometric framework as stated under 9 (see above)	

* "National Task" means that the work has to be done by the experts of the DRB state(s)

** "DRB GIS Task (contractor)" means that the work has to be done centralised by a contractor – the tasks occur usually only once per phase

For the input of transboundary lakes into the DRB GIS system two possibilities are conceivable. One possibility is that a lake's riparian countries could agree on a responsible party. Only that party (country) would then upload the lake data into the system, which constitutes an exception to the rule that only data within a countries' borders may be uploaded (compare chapter 4.3 "Data Delivery Guidelines"). Otherwise, the two countries can also agree to harmonize the lake data (geometrically and thematically, i.e. match geometry at the border and adjust attribute values to guarantee that both lake parts contain the same values) and upload their respective national parts of the lake separately. At its 11th meeting in Vienna in January 2005, the GIS ESG opted for the first possibility.

A similar problem arises for transboundary groundwater bodies. For that matter, the GIS ESG decided that each country should report their groundwater bodies separately, and a dissolve code (allowing the combination of groundwater bodies that belong together) would be added to the list of attributes for groundwater bodies.

The data can be put into the DRB GIS for working purposes, where the person responsible (reconcile user) can observe problems of mismatched data positions along the state boundaries (based on inadequate data but without topological error of overlapping).

At the national level, the cooperation between the authorities responsible for the DRB GIS data or the WFD implementation process and the national mapping agency may be necessary.

[11] The establishment of working areas is still under discussion

4.2. Metadata

The metadata model should be based on ISO 19115[12]. The mandatory core metadata for geographic datasets have to be included to meet future requirements, but it would be advisable to create a DRB GIS Community Profile or find a registered Metadata Profile that fulfils the DRB GIS needs.

For the generation of metadata, an xml schema will be provided for download from the DRB GIS system. This schema can then be used to create metadata forms. For widely available software (e.g. ESRI) complete metadata editors based on this xml schema will be provided.

Mandatory core metadata for geographic datasets according to ISO 19115 are:

1. Dataset title
2. Dataset reference date
3. Geographic location of the dataset
4. Dataset language
5. Dataset character set
6. Dataset topic category
7. Abstract describing the dataset
8. Metadata language
9. Metadata character set
10. Metadata point of contact
11. Metadata date stamp

Optional core metadata for geographic datasets according to ISO 19115 are:

1. Dataset responsible party
2. Spatial resolution of the dataset
3. Distribution format
4. Additional extent information for the dataset (vertical and temporal)
5. Spatial representation type
6. Reference system
7. Lineage
8. On-line resource
9. Metadata file identifier
10. Metadata standard name
11. Metadata standard version

In Annex B a detailed list of suggested ISO 19115 metadata for the DRB GIS (including examples and codelists) is provided. To make the table more concise, the metadata in the list are grouped in the following metadata topics:

- Common Metadata
- Contact
- Data Identification
- Data Constraints

[12] ISO 19115: Geographic Information - Metadata

> Reference System
> Data Quality
> Data Details

4.3. Data delivery guidelines

Data input to the DRB GIS is accomplished via data input routines (compare also chapter 5.3.3 "Data Upload"). The requirements for data to be uploaded to the system are

> data has to be delivered by each state only within the approved state boundaries (exceptions from this rule exist for some layers, see chapter 4.1.2)
> in shape format
> in a geographic coordinate system (decimal degree)
> in ETRS89 (or WGS84 if ETRS89 is not available)

In maps and webmaps available in the DRB GIS, the data will be presented the following way (compare Figure 7):

> Projection: Lambert Equal-Area Azimuthal
> Central Meridian: 20°
> Reference Latitude: 47°
> Ellipsoid: ETRS89
> Minimum/Maximum scale depends on input data

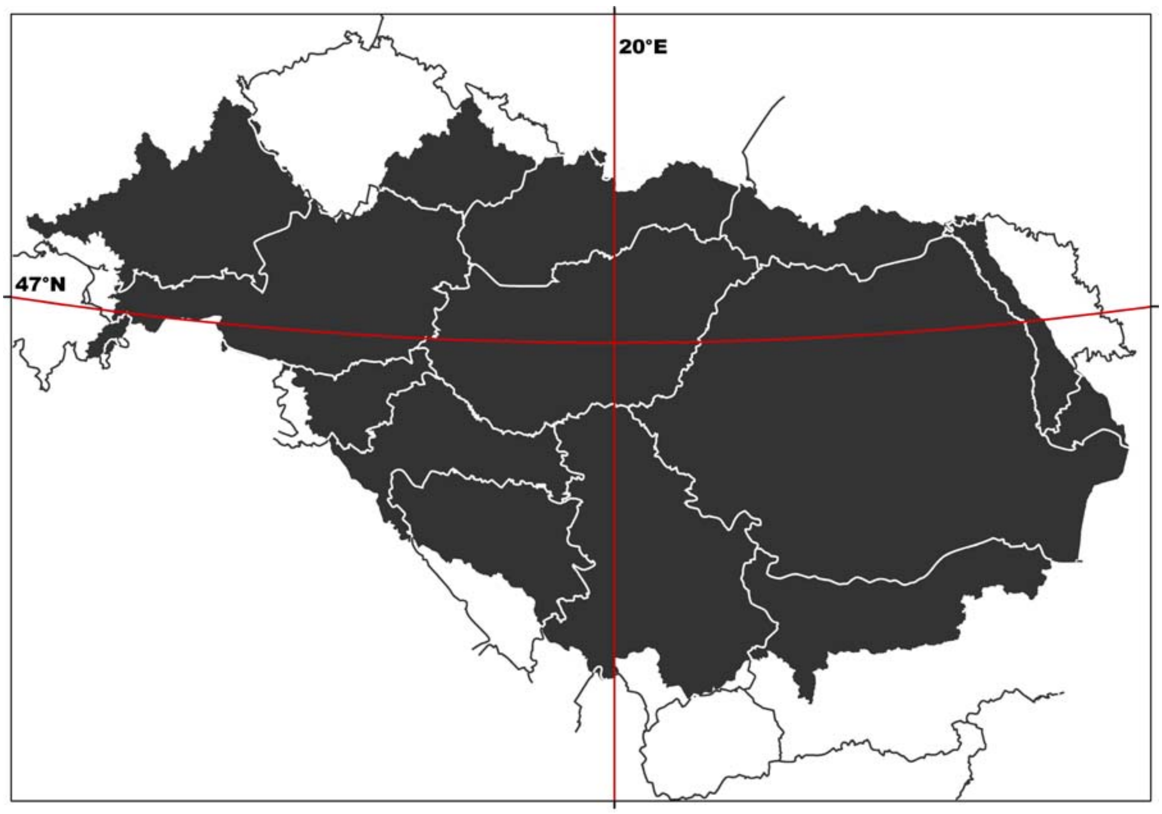

Figure 7: Data in display projection as stated above

4.4. DRB GIS Master Input Data List

The Master Input Data List for the 2nd phase of the DRB GIS ("pragmatic era") consists of the layers promoted by the WFD GIS Guidance Document13 plus the data already available in the Danube information system plus the data used for the roof report 2004. Table 1 in Annex A gives an overview of the datasets (layers) proposed for the DRB GIS. Furthermore, a list of attributes for each data set has been created wherever possible (see Table 3 in Annex A).

For the 3rd phase ("enhancement era"), the list can be extended with further topics discussed in the committees.

Since working areas for the DRB are still under discussion, a dataset "working areas" is not listed at the moment. It is not yet completely clear what that dataset will look like and which kind of links have to be established to other data sets. It is foreseen, however, to include the respective field in the templates created for the DRB GIS (compare chapter 5.3.5 "Templates for data upload").

4.5. Data constraints

It has already been pointed out that it can not be expected that all datasets required will be available for the DRB GIS immediately and in the accuracy desired. Thus the possible data constraints have to be listed, the most important being

- lack of data (problem solving has to occur on national level and/or central level, depending on kind of data)
- harmonisation problems (problem solving: bilaterally)
- generalisation problems (problem solving: centrally within GIS ESG)
- coding problems (problem solving: central level and/or consultant)

The resolution of the input data sets requested for the DRB GIS plays a significant role in dealing with the tasks listed above.

4.6. CCM vs. EGM[14]

As the question of using EGM or CCM data for reporting with the DRB GIS was discussed at the 15th RBM EG Meeting in Brussels (October 2004), the Umweltbundesamt was asked to include an evaluation of the usability of the two datasets for the DRB GIS in this report.

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[13] Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance Document No 9 Implementing the Geographical Information System Elements (GIS) of the Water Framework Directive. Produced by Working Group 3.1 – GIS.

[14] first draft by Károly Futaki, Info Mgmt and Admin Officer, ICPDR Secretariat; substantial amendments by Umweltbundesamt

Reference: Jürgen Vogt et al.: CCM River and Catchment Database, version 1.0. EUR 20756 EN, June 2003, compare http://agrienv.jrc.it/activities/pdfs/CCM-Report-EUR20756EN.pdf (31. 1. 2005)

4.6.1. Background Information

CCM Data

In response to an increasing need for more detailed European river network and catchments data layers for analyses (i.e. quantity, quality, trend of water resources, environmental pressures and impacts), the JRC Institute for Environment and Sustainability developed a European-wide database of drainage networks and catchments boundaries. The resulting data layers should become part of the Eurostat – GISCO database.

For the creation of the CCM database, highly automated data processing tools were applied. The automated extraction of topographic parameters, including valleys and drainage networks, from digital elevation models (DEMs) is assumed to be a viable alternative to traditional surveys and manual evaluation of topographic maps. With the algorithms for DEM analyses developed for CCM, a mapping scale of 1 : 500,000 to 1 : 250,000, should be achieved.

The DEM data used is of 100 or 250 metres grid size; for areas where DEMs at this resolution could not be acquired (e.g. Iceland, Russia), data from the HYDRO1K global digital elevation dataset with a 1,000 m grid-cell resolution was used (compare Figure 8).

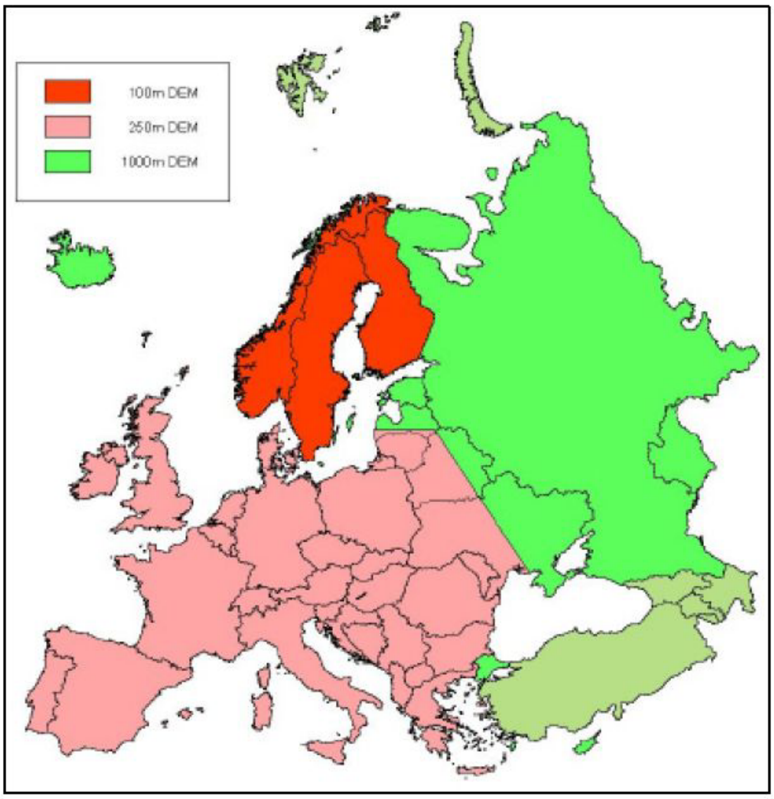


Figure 8: Grid-cell resolution of the DEM Data as basis for CCM

The area covered with the current version 1.1 of the CCM database extends from the Mediterranean to northern Scandinavia and from the Atlantic Ocean to roughly 38 degrees Eastern longitude. Figure 9 shows the CCM river network layer in the Danube River Basin.

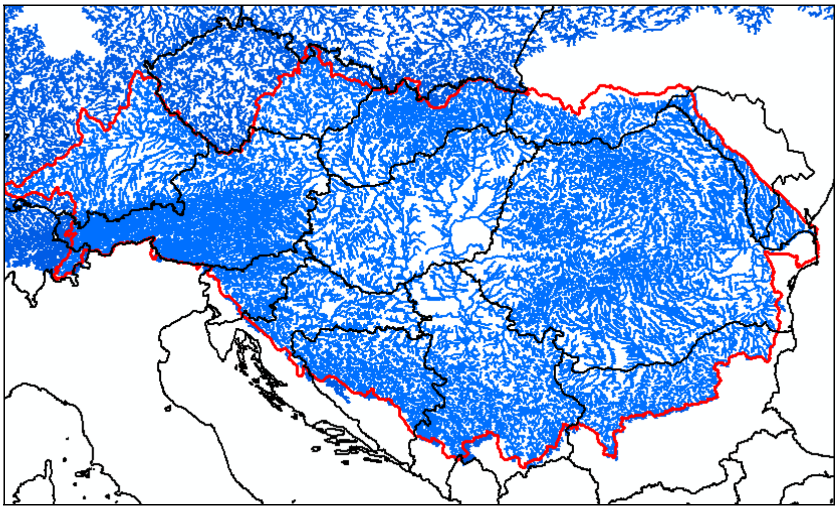


Figure 9: CCM River Network Layer in the DRB

In line with the recommendations given in the WFD GIS Guidance Document[15], the Pfafstetter coding system has partly been implemented in the CCM database. Pfafstetter codes can be used directly to determine if discharge in a sub-catchment impacts on a potentially downstream channel. In principle, this can be achieved without applying specific GIS analysis. However, Pfafstetter codes are not able to cater completely for lakes and marine waters and further consideration is required in order to produce a system that adequately covers all waters in an integrated way.

EuroGlobalMap (EGM) Data

EGM[16] is a pan-European dataset containing basic geographic information at the scale 1 : 1,000,000. The dataset is harmonised and seamless which means that there are no gaps/overlappings between graphical objects initially derived from different sources. EGM is produced in cooperation with the National Mapping and Cadastral Agencies (NMCAs), that is, by using official national databases. The current release v1.1 of EGM covers 35 European countries (compare Figure 10).

[15] Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance Document No 9 Implementing the Geographical Information System Elements (GIS) of the Water Framework Directive. Produced by Working Group 3.1 – GIS.

[16] compare http://www.eurogeographics.org/eng/04_products_globalmap.asp (31. 1. 2005)

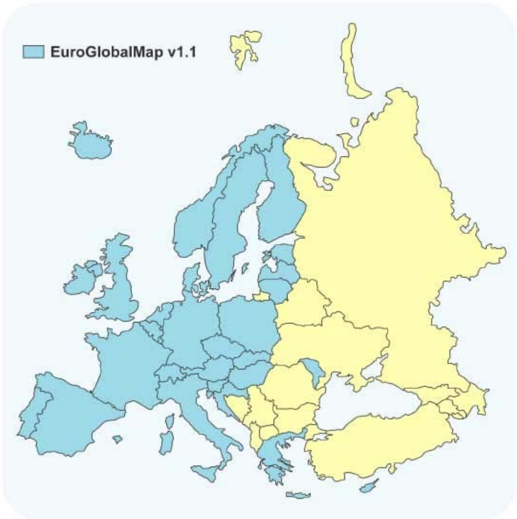


Figure 10: Coverage of EGM data v1.1

EuroGlobalMap contains the six themes (each including one or several layers):

> Administrative boundary
> Hydrography
> Transport
> Settlements
> Elevation (elevation points)
> Named location (geographical names)

Figure 11 shows the EGM water layer available for the Danube River Basin.

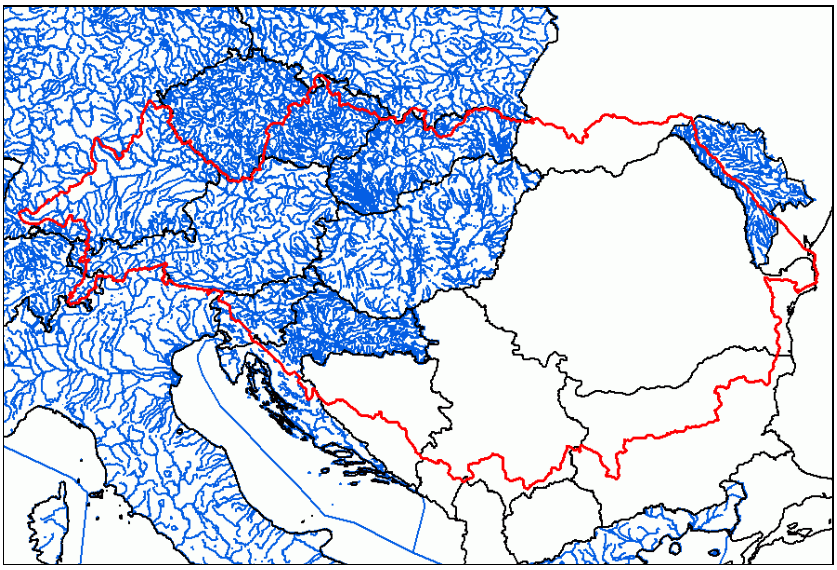


Figure 11: EGM water layer in the DRB

4.6.2. Exemplary comparison of EGM, CCM and/or national data

For the evaluation of completeness, topological correctness and the positional accuracy of the CCM River Network Database, data from Germany, Austria, Hungary and the Czech Republic were compared to EGM and/or National Data. As for the EGM data, the water line theme of the EGM's Hydrography layer was used, which contains larger rivers that are presentable at a scale of 1 : 1 Million. Most of the rivers contained in that dataset are named and selection according to the river basin size is possible.

Germany

The "Bundesamt für Karthographie und Geodäsie" (Germany)17 compared the CCM data with the official national river dataset for Germany (DLM100018 and DTK2519) in an investigation report in 2003. In this study, some severe errors concerning the topological correctness of rivers were found: in CCM rivers connect that do not meet in the DLM1000, and the order of confluences along a river in CCM does not correspond to the order in DLM1000 (compare Figure 12). The most eminent discrepancies were found in the flat regions of the country, i.e. in northern Germany and the Rhine and Danube river plains.

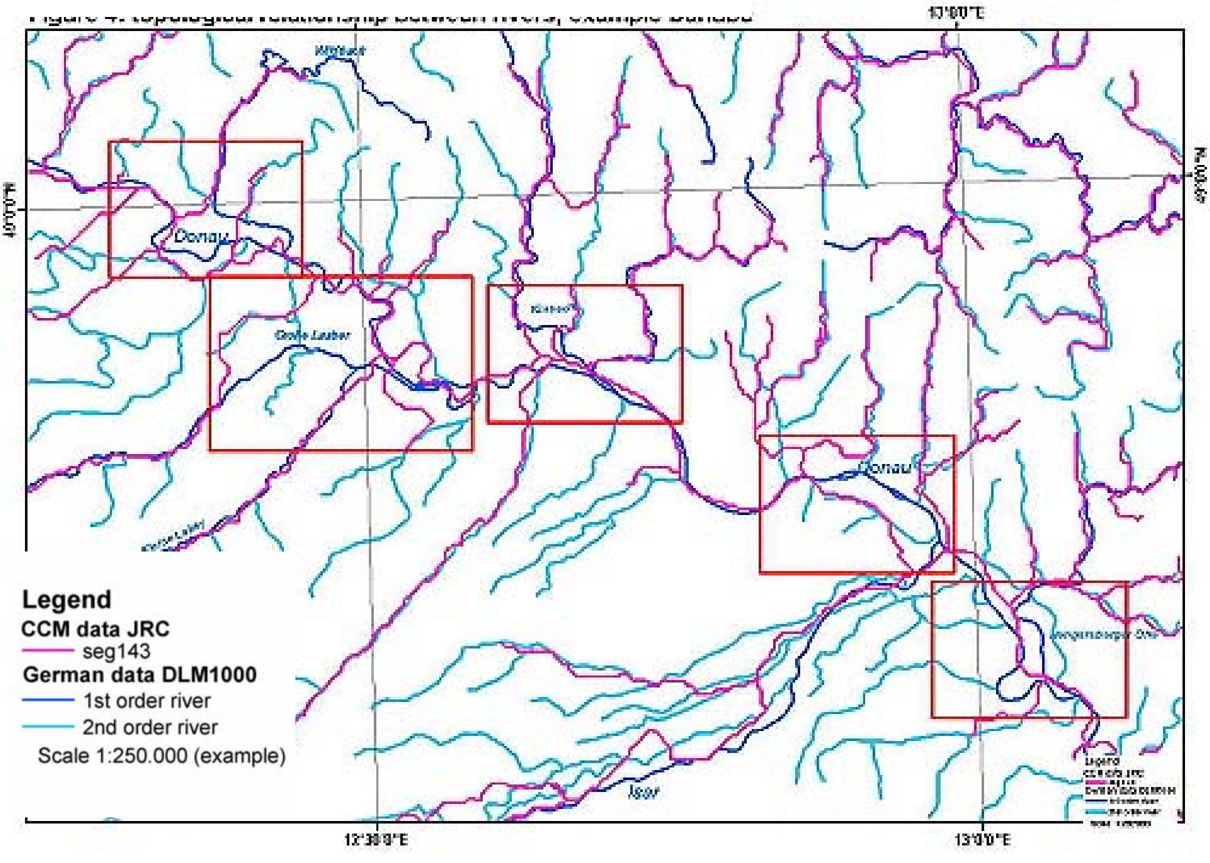


Figure 12: Germany: topological relationship between rivers (DLM1000, CCM)

[17] Bundesamt für Kartographie und Geodäsie: Investigation Report: Comparison CCM data with DLM1000 and DTK25. Author Sonja Werhahn, BKG, 24. 7. 2003.

[18] Digitales Landschaftsmodell (digital landscape model) 1 : 1,000,000

[19] Digitale Topographische Karte (digital topographical map) 1 : 25,000

Figure 13 (CCM and EGM data in the same river sections as shown in Figure 12) also demonstrates the shortcomings of the CCM data. While EGM data match with the national river data quite well, the topological and positional inaccuracies of the CCM data are evident.

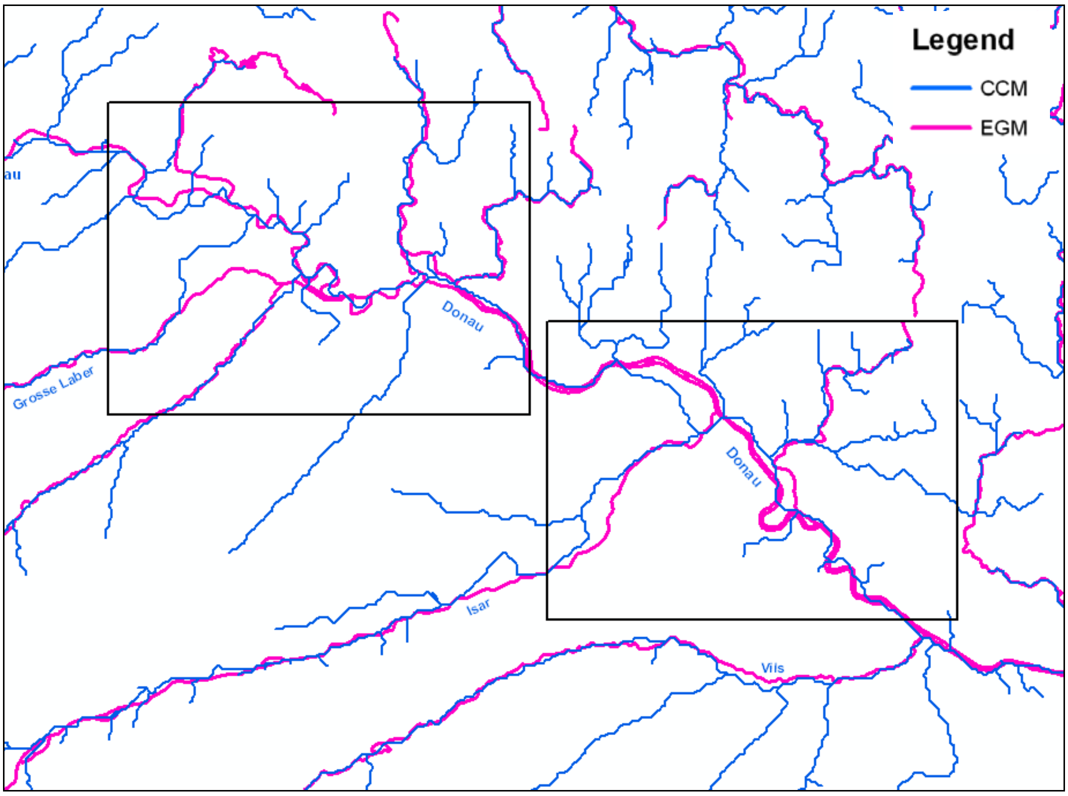


Figure 13: CCM and EGM data for the German Danube

Austria

For an exemplary evaluation of Austrian data, the national river dataset of rivers with catchments > 100 km² (scale comparable to EGM data) was compared to CCM and EGM data. Data problems occur mainly in the following fields:

- **Completeness**: rivers in the CCM often are not fully mapped up to their source (compare Figure 14)
- **Topological relationship between rivers**: in CCM, rivers connect that do not meet in the EGM or in the national dataset; the order of the confluences along a river in CCM does not correspond to the sequence in the compared datasets (compare Figure 15)
- **Positional accuracy**: the position of the rivers in CCM does not correspond to the position of the national river system and the EGM (compare Figure 16)
- **Harmonisation with other datasets**: e.g. administrative borders do not match with border rivers (compare Figure 17)

While most differences between the datasets observed occur in the flatter Austrian regions (east), the positional conformance of the CCM improves in the mountainous areas. In direct comparison with the national river dataset, the EGM water layer shows a high level of topological correctness and positional accuracy. As becomes most obvious in the example of the border river March, harmonisation with administrative borders is completely missing and thus the CCM river data cannot be used for GIS analyses or for (large-scale) cartographic representation together with other themes.

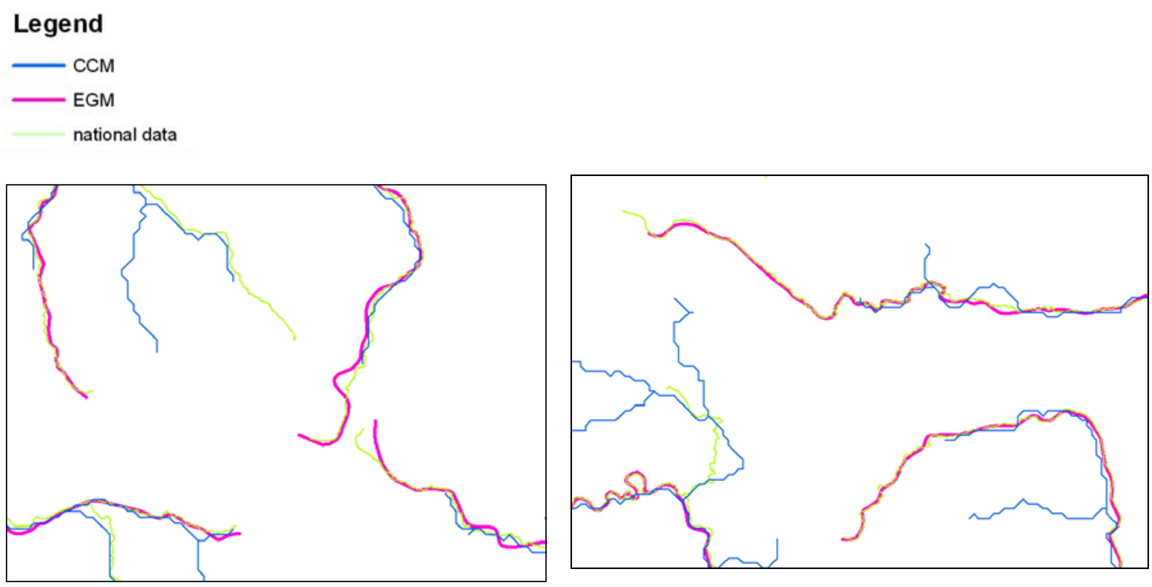


Figure 14: Incompleteness of CCM in comparison to EGM and national Austrian river data

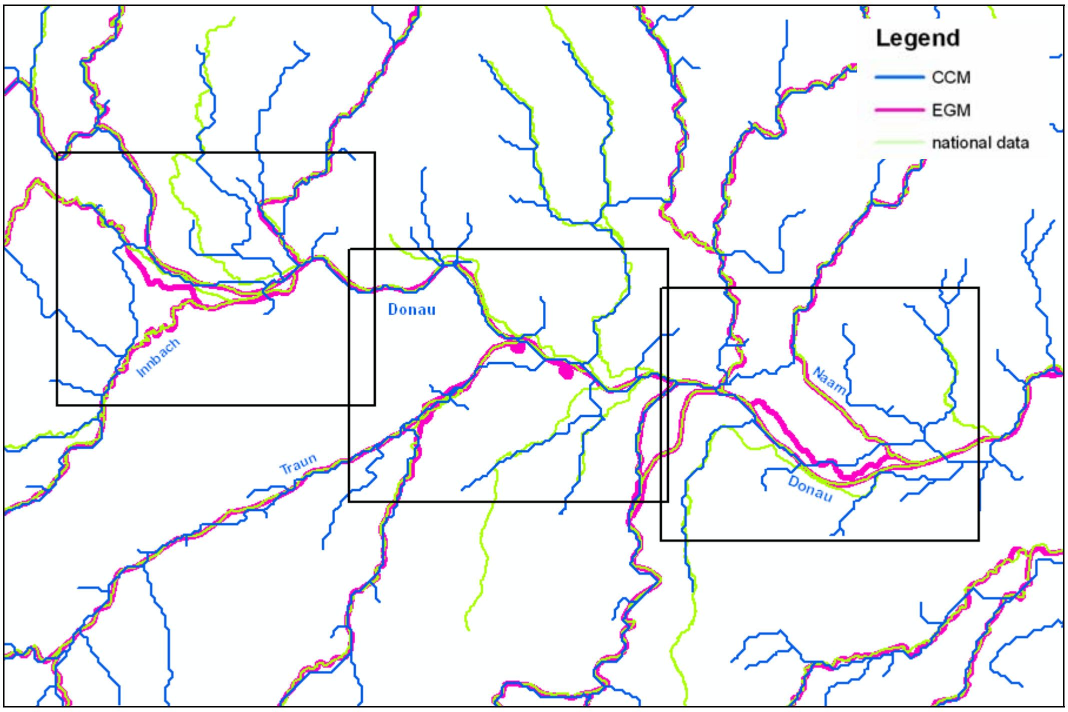


Figure 15: CCM/EGM/Austrian national data: topological discrepancies

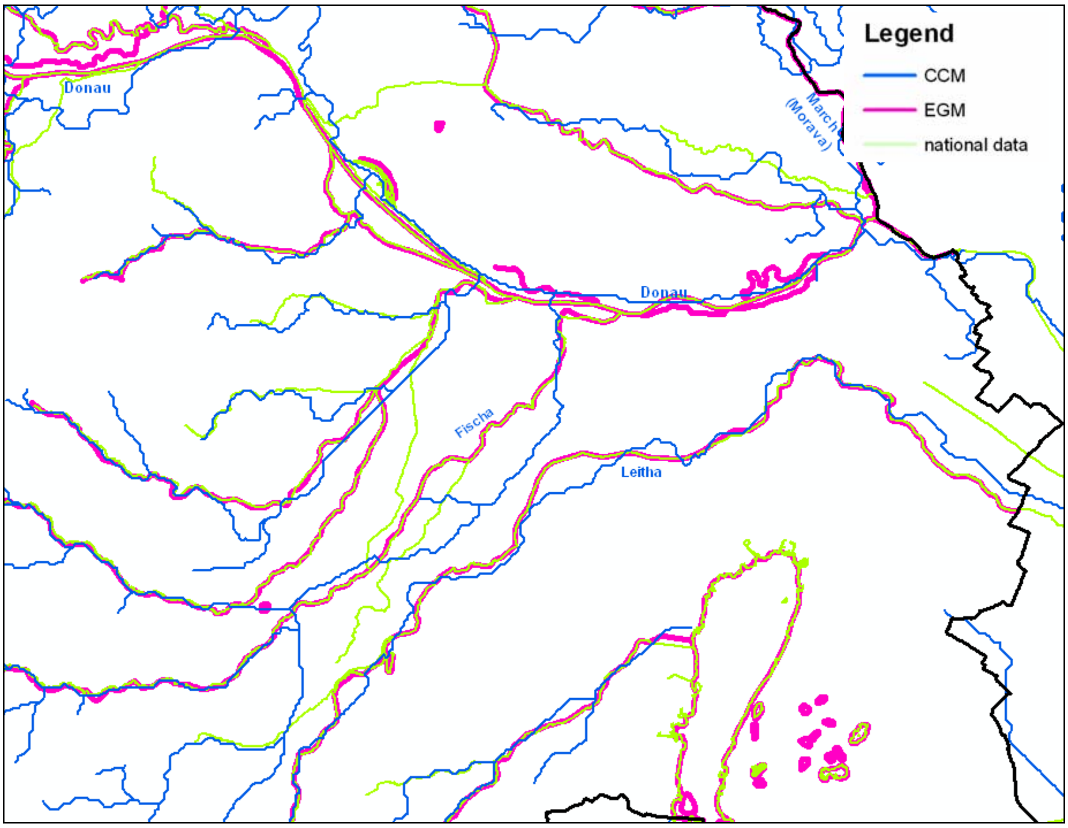


Figure 16: CCM/EGM/Austrian national data: positional discrepancies

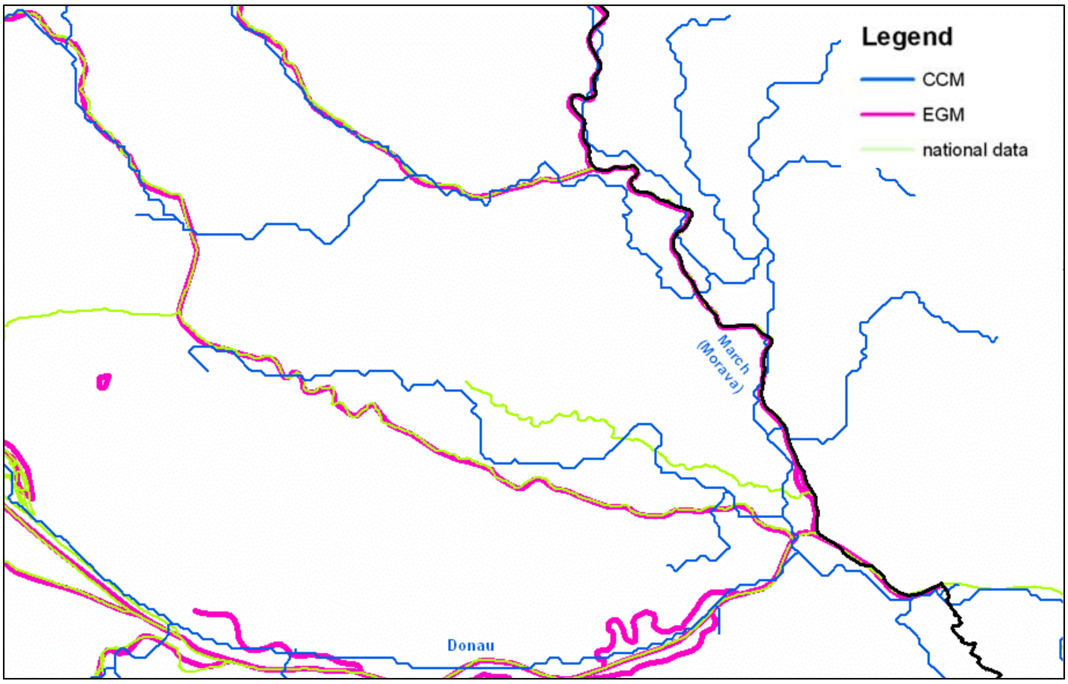


Figure 17: CCM/EGM/Austrian national data: Lack of harmonization

Hungary

For Hungary examples of the inaccuracies of the CCM dataset in comparison with national river data were provided. In the Hungarian Plain, the positional inaccuracies stemming from the method of data creation in the CCM are most obvious; also, the lack of harmonization of river and lake data is apparent (compare Figures 18 and 19).

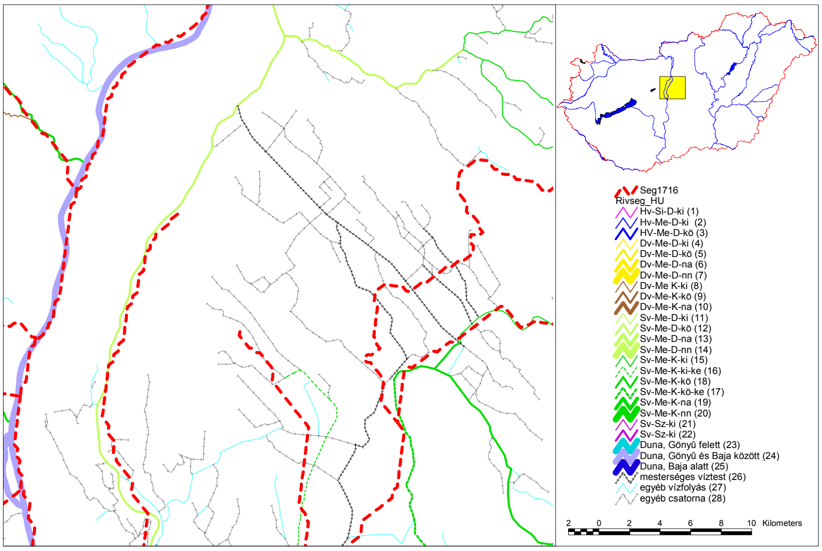


Figure 18: Positional errors in a Section of the river Danube (red dotted line: CCM, other: Hungarian national data)

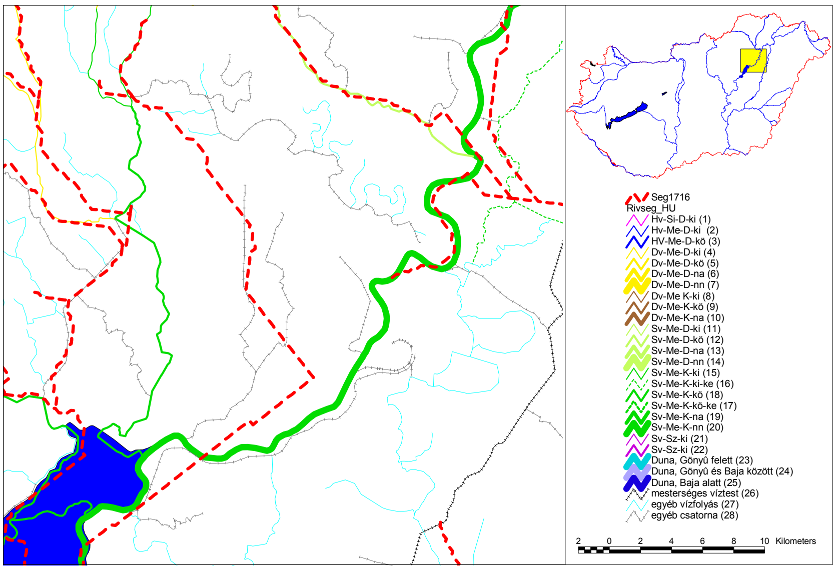


Figure 19: Positional errors in a Section of the river Tisza (red dotted line: CCM, other: Hungarian national data)

Czech Republic

An example from the Czech Republic was taken to show that the CCM dataset, in contrary to the EGM data, does not contain artificial waterways (compare Figure 20, where the Opatovick Canal is not contained in CCM data. Also, positional differences in the two river datasets are evident.)

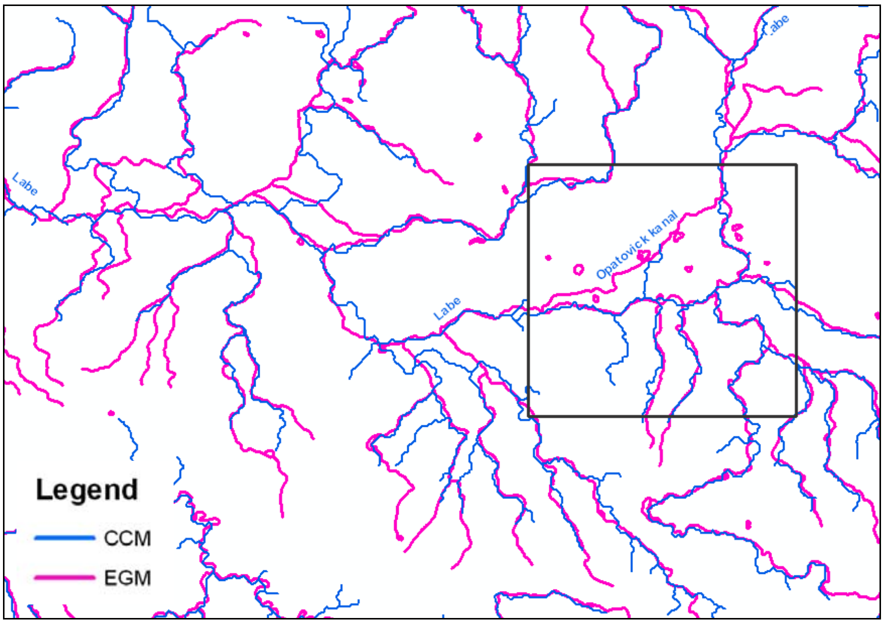


Figure 20: The River Labe and the Opatovick Canal in the Czech Republic

4.6.3. Conclusion

Taking the conclusions drawn from the examination of random checks of CCM data in comparison with EGM and/or national data as well as other known factors into account, the usability of the CCM dataset for the DRB GIS has to be assessed as "not good". The CCM dataset in its current version 1.0 primarily shows the following limitations:

> Especially in flatter regions (e.g. Hungarian Plain), some rivers are not correctly reported and exhibit distinct **positional errors**. The positional accuracy of the CCM database does not seem to correspond to the given map scale of 1 : 250,000 to 500,000, but rather to a much smaller scale.

> The CCM data does not resolve small headwater creeks which results in **lack of data** in river's source regions.

> **Topological errors** (e.g. connecting rivers, wrong sequence of confluences) are common.

> **No artificial waterways** are included in the CCM dataset.

> **No names for rivers and lakes** are contained, which makes searching and selecting difficult. For cartographic display, names are indispensable.

> The CCM data are **not harmonized with other themes**, e.g. lakes or administrative data. Map presentation or GIS analysis together with other layers is not possible in an error-free manner.

- The rivers in CCM **can not be selected by their basin size**, which is opposed to the WFD reporting requirements (where rivers are classified according to their catchment size)

In the light of the experience and errors reported by testing users, it is foreseen to prepare a second version of the CCM database by July 2005. Besides the correction of obvious errors, the following issues will be considered in version 2.0:

- application of underlying grid-resolution of 100 x 100 metres
- further study of coding problem and full implementation of a coding system
- naming larger rivers and lakes (catchment size not defined)
- calculation of a set of catchment characteristics and proxy pressure indicators
- recalculation of sub-basins along lake perimeters
- merging of small coastal drainage areas and small drainage areas along lake perimeters into larger entities

With these improvements in version 2.0, a considerable part of the problems with the CCM database may be solved. It has to be expected, however, that the following shortcomings of the CCM data will yet remain prevalent in the new version:

- still does not contain artificial waterways
- still no names for all rivers and lakes
- considerable efforts needed to rectify the problems shown for the water bodies in the Hungarian Plain or the Danube Delta
- considerable efforts needed to incorporate other themes, like for example the administrative borders (absolutely not considered within CCM) or lake data
- still no classification of rivers by their basin size possible

Taking into account the above remaining problems, and the commitment of the UNDP/GEF Danube Regional Project to support ICPDR in this matter, it is advisable for the next two or three years to continue with the EGM (ver1.1 or higher) until CCM reaches an acceptable level for the DRB GIS purpose. Not only does EGM represent a more accurate dataset, but its **usage is indispensable** – at least for the first stages of a DRB GIS – **for data harmonization reasons** (compare 4.1.2 "Geometry Framework"). The EGM does not only feature a dataset of administrative boundaries that stem from the respective NMCAs (and thus are reliable, are harmonized geometrically between the countries and are updated regularly), but also provides river **data that can function as a framework for transnational data harmonization** in the DRB GIS (river crossing points at boundaries). The use of EGM data is also recommended by the RBM/GIS ESG in the Summary Report on EGM evaluation[20].

After that period (2-3 years) and when CCM data is available in a revised version, the CCM should be re-analysed for its usability and may well prove a viable solution for DRB-level reporting then. For countries where no EGM is currently available, the best river dataset disposable should be used for reporting, the CCM data being one option for that purpose.

[20] Summary of the EuroGlobalMap ver. 1.1 National Evaluation Reports, Draft 3 (26 Jan. 2005) by Eva Sovjákova (chairperson RBM/GIS ESG), see www.icpdr.org/DANUBIS

5. TASK 4: SYSTEM FUNCTIONS

In this chapter, the system functionalities required for **creating the geo-information products** defined in Task 2 (Geo-information products) are described. The DRB GIS will be a **web based geo-information system** as opposed to a desktop workstation with GIS software. It is important to note that this web application can not replace any national GIS system - it would not make (economic) sense to re-build any national GIS on the server of a DRB GIS. The purpose of the web-based DRB GIS is to combine the datasets of the Danube river basin area in order to generate a common view on the actual state of the Danube river basin in the participating countries. Therefore, the web GIS application does not include the whole functionality of professional GIS software but provides a flexible **web mapping and querying tool** for experts as well as for the general public. By making use of the **download tool** of the DRB GIS web portal, the users can conduct further specific analyses offline.

The definition of data handling functions and conversion requirements during import or output processes in the DRB GIS will be described applying an UML method which is commonly used for describing **workflows**. These diagrams are called "**activity diagrams**" and show which part of the system has to be "activated" to pass results to other components so as to gain an appropriate result at the end.

Usually, maps produced with GIS software follow **specific principles of cartographic design**. These map documents are created for one defined scale and paper format. The purpose of web mapping is completely different in so far as geodatasets are shown in various scales and different map extents. The DRB GIS will therefore include **printing options** and the possibility to **save graphics**, but the maps can not – per definition – have the same cartographic quality as cartographically perfected paper maps (for example, labels of features may overlap or disappear if the zoom level is not appropriate).

The use of system functions that are available as **predefined software components** is preferred to programming them at one’s own - it is simply much more economical to use existing solutions than to develop them oneself. Especially in a system that allows **user interaction** via a graphical user interface, the error checking phase of the programming process can be extremely time- and thus cost-consuming. With predefined software components, almost no error checking is necessary. This decision is also important for the further **maintenance** of the system: while a regular update can be expected for predefined software components, the enhancement of self-made components may consume a considerable amount of time and money. System functions that are not available as predefined software components will, however, be developed specially for the DRB GIS framework.

In the following chapter, the specific **OGC** (Open Geospatial Consortium) and **ESRI** software components required for implementing **interoperable solutions** via the Internet are described. Furthermore, potential technical problems and limitations of these components in the context of the Water Framework Directive are pointed out. The descriptions of these solutions can be used by the ICPDR's representatives and expert groups (RBM, GIS ESG) to come to a decision which system best meets the requirements of a Danube river basin GIS.

The software architecture is defined with state-of-the-art components as of the end of the year 2004. Should an intermission of several months occur between the system definition and the implementation of the DRB GIS, the hard- and software requirements should be revised to take the latest developments into account. Software providers' changes in licensing policies may result in costs slightly differing from those calculated here.

5.1. System configuration & Hardware requirements

The system configuration and hardware requirements depend on which **software architecture** will be chosen for the DRB GIS. Basically, there are two main ways to create the DRB geospatial infrastructure:

- commercial off the-shelf (COTS) GIS software
- open source GIS software

The so-called **COTS (commercial off-the-shelf) products** are developed by the software industry to fulfil general tasks in one or more business segments with similar requirements. In the field of geographic information systems, ESRI is the world leading software provider. The product portfolio ranges from desktop GIS applications, functional extensions and geo-enabled databases to geo-viewers and mapping servers. The **most important aspects** to be taken into account when using ESRI products are:

- They are **commonly used worldwide** in the field of professional GIS (ESRI currently has an approximate 36 percent share of the GIS software market worldwide).
- The **ESRI shapefile data format** is a widely spread industry standard. Data exchange with most other GIS software is possible (e.g. Intergraph Geomedia Professional, Golden Software Surfer etc.).
- When using COTS, the **software development costs** are reduced, because solutions are already available (reduces programmatic, technical, schedule, and cost risk).
- Many **solutions** are already available, but ESRI software is **not special-purpose** COTS or COTS used only in specific markets. For the European WFD, no specialised products are available.
- For **long-term systems**, maintenance is available and new releases are published periodically (within the last two years, ESRI has released three updates of its product line).
- ESRI is **member of the Open Geospatial Consortium** (OGC) and as such is striving to provide OGC-compliant software.

On the other hand, there are **open source products** which have gained a high level of proficiency over the last few years. The main aspects to consider with open source products are:

- The **source code is available**. Any changes to the current project are (theoretically) possible. However, the resources required for the adaptation of code (time and money) have to be checked in advance.
- If many specific tools have to be developed for a project, open source software is **easier to customize** because each function is accessible.
- For specific purposes, **tools** are **already available**, while commercial products (COTS) probably do not consider this business segment as interesting enough to develop expert software.
- The **community** of open source software users is more interested in the exchange of knowledge. Far more user groups, newsgroups and possible solutions for specific situations are available.
- The advantage of gaining **more independence from software industry** is in opposition to **potentially higher risks**. The further development of open source software is not always definitely clear.
- **Professional support** is sometimes difficult to find, and **new releases** are not published regularly but only when and if the people involved have enough resources to

continue development. The analysts and programmers of the community involved decide how and at what pace the development goes on.

> Open source software is **not freeware**. Similar costs as for commercially distributed software may arise. Further details to open source software are available at http://www.opensource.org/docs/definition.php (31. 1. 2005)

The DRB GIS is a web-based system that features a **long-term planning horizon**. While COTS software like ESRI will be - from the current point of view - enhanced continuously in the ongoing years, no similar guarantee can be given for open source products.

This report describes **three alternatives** for the implementation of a DRB GIS. While the first one concentrates on COTS products, the second portrays an open source alternative. The third represents a mixture of both, combining the advantages of the first with the advantages of the second type.

The following figure of the **system configuration** shows an overview of the main system functions required by DRB GIS:

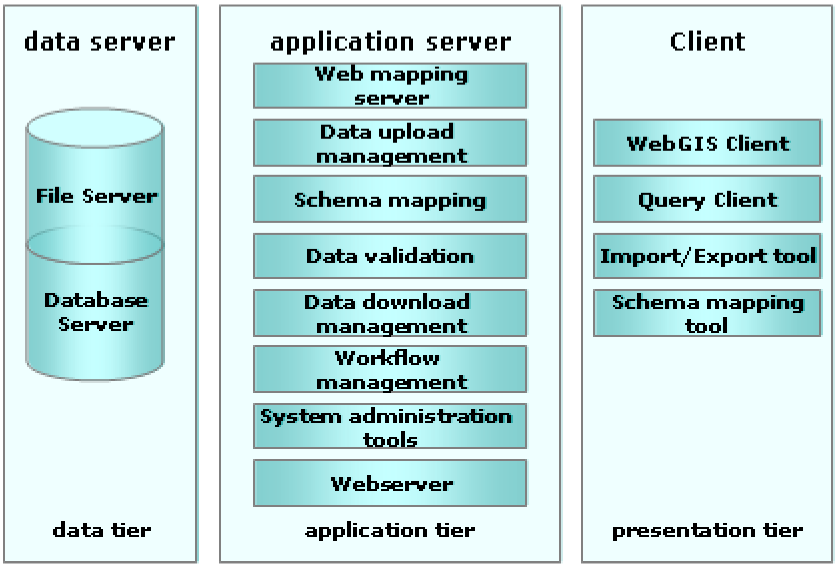


Figure 21: System configuration for the DRB GIS (overview)

The **system configuration** is divided in three tiers:

> Data tier

> Application tier

> Presentation tier

The **hardware requirements of the DRB GIS** result from the demands for data tier and application tier - these two system components represent the infrastructure required. The **hardware** for a DRB GIS will thus consist of two servers:

> Data server (data tier)

> Application server (application tier)

Both servers should use the same **operating system**, where we suggest Microsoft Windows 2003 Server.

The **data server** represents the main data pool for the DRB GIS. All datasets that are available for visualization, querying and download are stored here. Since these datasets need regular backup, specific access restrictions and because of performance requirements, data tier and application tier should be separated on two servers.

The **application server** manages the tools provided by server-side processing. The client interacts with these software components, but the main program intelligence is situated on the server. To be able to provide interaction with the data available for the Danube river basin, the user needs tools for retrieving information, which are provided by the presentation tier of the system.

The **presentation tier** consists of the various user interfaces which are implemented server-based and accessed via the web browser. All the user needs is a web browser; no further installation is required.

The three alternatives for a DRB GIS as described in the following mainly differ in the usage of web mapping server software and database software. For the other components, one best-practice version is described.

5.1.1. Solution 1: COTS products

As already mentioned above, the world leading GIS software producer is ESRI (Environmental System Research Institute Inc.). Due to the fact that most governments in European countries are using these products, the COTS solution proposed here is based on **ESRI ArcIMS** (**I**nternet **M**apping **S**oftware).

The following **technology portfolio table** details the system components required for Solution 1.

Table 6: Technology portfolio used for COTS solution

System component	Software	Software provider/creation
Operating System	Windows 2003 Server	Microsoft
Database System	ORACLE 10g	ORACLE
Web Mapping Server	ESRI ArcIMS	ESRI
Web Mapping Client	DRB GIS solution	customization of ESRI ArcIMS webclient
Webserver	Apache HTTP Server Jakarta Tomcat	Apache Software Foundation
Workflow management	DRB GIS solution	Jboss jBPM (Java Business Process Management)
Data upload/Data download tool	DRB GIS solution	customization of ESRI ArcIMS webclient
Schema mapping	DRB GIS Solution	
Validation	DRB GIS Solution	
System administration tools	DRB GIS Solution	Tomcat & ORACLE 10g database (customization of built-in functionality)
Geodata management	Fileserver with ESRI Shapefiles	ESRI
Web portal	Java Server Pages	Sun Microsystems
ESRI Interfaces	ESRI Image Service, ESRI Feature Service	ESRI ArcIMS Server
Query Client	DRB GIS Solution	customization of ESRI ArcIMS WebClient

5.1.2. Solution 2: Open Source products[21]

The open source solution differs from the COTS solution mainly in the use of different web mapping software. Depending on the decision if Open Geospatial Consortium (OGC)[22] interfaces should be implemented, two mapping servers are available which could be used. While GeoServer is OGC's reference implementation and thus a good solution for Web Feature Services, Deegree is the Web Mapping Server more appropriate for the Web Mapping Service plus it also implements the Web Feature Service.

Table 7: Technology portfolio used for Open Source solution

System component	Software	Software provider/creation
Operating System	Windows 2003 Server	Microsoft
Database System	MySQL 4.1.7	MySQL AB
Web Mapping Server (OGC WFS Reference Implementation)	GeoServer	The GeoServer Project
Web Mapping Server (OGC WMS Reference Implementation)	Deegree Webmapping Server	Deegree
Web Mapping Client	DRB GIS solution	customization of webmapping webclient
Webserver	Apache HTTP Server Jakarta Tomcat	Apache Software Foundation
Workflow management	DRB GIS solution	Jboss jBPM (Java Business Process Management)
Data upload/Data download tool	DRB GIS solution	customization of webmapping webclient
Schema mapping	DRB GIS Solution	
Validation	DRB GIS Solution	
System administration tools	DRB GIS Solution	Tomcat & ORACLE 10g database (customization of built-in functionality)
Geodata management	Fileserver with ESRI Shapefiles	ESRI
Web portal	Java Server Pages	Sun Microsystems
OGC Interfaces	Web Mapping Service (WMS), Web Feature Service (WFS)	
Query Client	DRB GIS Solution	customization of webmapping webclient

[21] for an example for a Web Application implementing OGC services see www.geoland.at (31. 1. 2005)
[22] see www.opengeospatial.org (31. 1. 2005)

5.1.3. Solution 3: Composite solution (Open Source and COTS products)

Table 8: Technology portfolio used for mixed COTS & Open Source solution

System component	Software	Software provider/creation
Operating System	Windows 2003 Server	Microsoft
Database System	MySQL 4.1.7	MySQL AB
Web Mapping Server	ESRI ArcIMS*	ESRI
Web Mapping Client	DRB GIS solution	customization of ESRI ArcIMS webclient
Webserver	Apache HTTP Server Jakarta Tomcat	Apache Software Foundation
Workflow management	DRB GIS solution	Jboss jBPM (Java Business Process Management)
Data upload/Data download tool	DRB GIS solution	customization of ESRI ArcIMS webclient
Schema mapping	DRB GIS Solution	
Validation	DRB GIS Solution	
System administration tools	DRB GIS Solution	Tomcat & ORACLE 10g database (customization of built-in functionality)
Geodata management	Fileserver with ESRI Shapefiles	ESRI
Web portal	Java Server Pages	Sun Microsystems
OGC Interfaces	Web Mapping Service (WMS), Web Feature Service (WFS)	ESRI ArcIMS Server
Query Client	DRB GIS Solution	customization of ESRI ArcIMS WebClient (OGC compliant)

* Linux Red Hat as open source alternative may be used instead, but it has to be clarified if OS support can be guaranteed. For both systems, know-how and experience are available at the Umweltbundesamt.

5.1.4. Webmapping server product fact sheets

In 1997, ESRI started in the field of web mapping with ArcView IMS (including a Java based, pre-packaged web client interface called Map Café). By now, long-term experience has been incorporated into the software architecture. ESRI ArcIMS has become a high performance, scalable webmapping software. The workload of interaction with the user occurs mainly on the server, only the request and the result are sent via the internet.

It is our intention that the DRB GIS should provide access to geo-information products without installation of any additional software at the client. The only essential installation for every user is a web browser (e.g. IE 5.5 up, Firefox 1.0 up). As for **OGC services**, ArcIMS 9.0 presently only provides the web mapping service (WMS). The previous release, ArcIMS 4.0.1, also implemented the web feature service (WFS), but the integration of this component in ArcIMS 9 has apparently been postponed to ArcIMS version 9.0.1 or 9.1. The next release is announced for the upcoming year. Instead of OGC compliant WMS and WFS, ArcIMS currently provides its own standard called **ESRI image service** and **ESRI feature service**. Both services are available for external ArcGIS clients via the internet. Geodata or images of geodata can be retrieved with desktop software and directly included in geoprocessing tools and models. But contrary to OGC intentions, these services exclude users of other GIS software products.

Table 9: Product fact sheet - ArcIMS 9.0

ArcIMS 9.0	
Hardware requirements	> memory/RAM: minimum 256 MB RAM recommended per CPU (all components) > disk space requirements: the disk space requirements for all ArcIMS components are 602 MB.
Operating system requirements	> Windows 2000 up > ArcIMS is only supported on Linux x86, on CPUs that adhere to the x86 architecture (32-bit), with supported Linux releases. It is required that the OS (binary) has not been modified. ESRI does not provide any support if products are installed on the developer's release of an operating system. The Linux patches from RHEL AS/ES will be supported as long as the patches are supported by the web servers and are from Red Hat without any modification to the latest kernel/glibc version.
JRE requirements	> JRE version 1.4.2 is supported
Supported Servlet Engines	> Tomcat 4.1.29 with mod_jk2 > Tomcat 5.0.27 with mod_jk2
OGC compliance	> WMS 1.1.1 > WFS 1.0.0 (only with ArcIMS 4.0.1)
URL	http://www.esri.com/ (31. 1. 2005)
Documentation	http://www.esri.com/library/whitepapers/pdfs/arcims9-architecture.pdf (31. 1. 2005)

The second web mapping software that is able to support the DRB GIS' use cases is **Deegree**. In the year 2000, Deegree (formerly known as Lat/Lon) started as a spin-off of the Institute of Geography, University of Bonn. The main objective of the Deegree software project is offering the possibility to build a spatial data infrastructure. Several Open GIS Consortium (OGC) and ISO/TC 211 standards are implemented. As the whole architecture of Deegree is based on OGC specifications and concepts, there are no problems to integrate standardized products of other vendors.

Besides Web Mapping Services (WMS) and Web Feature Service (WFS), further OGC services like Web Coverage Service (WCS), Web Catalog Service (WCAS), Web Gazetteer Service (WFS-G), Web Coordinate Transformation Service (WCTS) and Web Terrain Service (WTS) are available. While WMS and WFS are already widespread and commonly used, some of the other services still need further conceptual development.

In 2003, the Deegree project was made **official reference implementation for the OGC WMS 1.1.1 specification**. Furthermore, the realization of the reference implementations of

WCS 1.0.0 and CS-W 2.0 specifications (Catalogue Service-Web) in the context of OWS2 (OpenGIS Web Service Testbed 2) were assigned to Deegree.

Table 10: Product fact sheet - Deegree server

Deegree Webmapping Server > deegreeWFS 1.2.3 (OGC WFS 1.0.0) > deegreeWMS 1.1.2 (OGC WMS 1.1.1 reference implementation)	
Hardware requirements	> Memory/RAM: 128 MB RAM for demonstration, 512 MB for optimum application processor (PC) > optimum application hard disk space: 100 MB (without JDK)
Operating system requirements	> Windows NT up > Linux
JRE requirements	> JRE version 1.4.1 up (JDK 1.4.x up)
Supported Servlet Engines	> Tomcat 4.1 up
OGC compliance	> deegreeWMS 1.1.2: WMS 1.1.1 > deegreeWFS 1.2.3: WFS 1.0.0
URL	http://deegree.sourceforge.net/ (31. 1. 2005)
Documentation	http://deegree.sourceforge.net/tec/index.html (31. 1. 2005)

5.1.5. Database product fact sheets

While geometry in the DRB GIS will be stored in shapefiles, the storage of attribute data requires a database management system. **ORACLE Database** 10g is an **enterprise relational database management system**. The current release is designed for grid computing to gain more efficiency. Oracle Database 10g provides high quality service which is exceedingly important for lowering the risk of data loss. The database needs a server with high performance, enough disc space and also sufficient RAM.

A further reason for choosing ORACLE as software component is that the DANUBIS webportal currently is based on ORACLE database software, i.e. experience in administrating this kind of database is available at the ICDPR Secretariat. While the ORACLE application server's restrictiveness concerning customization has caused some problems for DANUBIS in the past, the database management system has worked fine so far.

Table 11: Product fact sheet - ORACLE

ORACLE 10g Standard edition ONE	
Hardware requirements	> memory/RAM: minimum 512 MB is required > minimum required swap space is 1 GB. Swap space should be twice the amount of RAM for systems with 2 GB RAM or less and between one and two times the amount of RAM for systems with more than 2 GB. > 2,5 GB of available disk space for the Oracle 10g software and another 1,2 GB for the database. The /tmp directory needs at least 400 MB of free space. > dual processors (e.g. 800 MHz Pentium III CPUs)
Operating system requirements	> Windows 2000 with service pack 1 or higher, or Windows Server 2003 > Linux x86 (e.g. Red Hat Enterprise Linux 2.1, Red Hat Enterprise Linux 3)
Protocol	> TCP/IP
Connectors	> ODBC > JDBC > ORACLE SQL*net

MySQL currently is the **most popular open source database management system**. MySQL is frequently used for web sites and business systems (e.g. Google) and represents a reliable alternative to higher-cost, more complex database technology. Its speed, scalability and reliability have reached a high level of professionalism so as to make it a reasonable choice for the DRB GIS. MySQL is available under the free software/Open Source GNU general public license (GPL) or a non-GPL commercial license.

The current generally available release, MySQL 4.1, introduces spatial extensions to allow the generation, storage, and analysis of geographic features. Although the OpenGIS geometry model is the basis of these spatial extensions, MySQL diverges from the OpenGIS specification. The spatial extensions currently are available for MyISAM tables only. Initially, the spatial extension was considered an alternative to ESRI shapefiles for storing geodata, but two important arguments oppose this solution:

- Due to the fact that MySQL 4.1 is the first version of MySQL to integrate spatial data, it does not seem advisable to use it at this early stage.
- The OpenGIS specification for spatial data is not really integrated yet: MySQL only implements a subset of the OGC's "SQL with Geometry Types environment" proposed by OGC (this term refers to an SQL environment that has been extended with a set of geometry types).

As mentioned in the table below, compatibility problems between Linux Red Hat and MySQL may arise; these have to be adjusted during the prototyping process.

Table 12: Product fact sheet - MySQL

MySQL 4.1 Generally Available (GA) release	
Hardware requirements	> dual processor with 512 K cache > a minimum of 200 MBytes is recommended
Operating system requirements	> 32-bit Windows operating system such as 9x, Me, NT, 2000, XP, or Windows Server 2003 > Windows NT, 2000, XP, 2003 permits to run the MySQL server as a service. > MySQL RPMs are currently built on a SuSE Linux 7.3 system, but should work on most versions of Linux that support rpm and use glibc.
Protocol	> TCP/IP
Connectors	> ODBC > JDBC via (MySQL Connector/J)

5.2. System functions specification

According to the Needs Assessment[23], the core needs for a DRB GIS should be satisfied by a **toolset for information production, handling, and dissemination.** The DRB GIS will make environmental geoinformation available via the Internet and should be the foundation database for further common (geo)datasets of the Danube River Basin.

The four **common needs** of user groups identified in the Needs Assessment are:

- maps
- a system on the overview scale
- a centrally initiated and developed GIS database
- public access

The most important **system functions** of the DRB GIS are outlined in the Strategic Plan[24]:

- **Provide data** for Member States GIS
- **Receive information** from Member States GIS
- **Provide information** for ICPDR users, Member States GIS, and external users including the public

The system functions are designed using UML (Unified Markup Language). The **use case diagram** is a state-of-the-art way to explain system functions on the basis of a common language. To facilitate mutual understanding, comments describing the use cases are added. A detailed specification of the most important use cases is integrated in Annex C. For a detailed description of special workflows, **activity diagrams** are added to show when, where, from whom and how input is required or output should be provided. These diagrams are added to the tool descriptions when necessary to understand the workflow in the background.

[23] Towards a Danube River Basin GIS: Needs Assessment and Conceptual Design for the Danube River Basin GIS System, KTH, Department of Land and Water Resources Engineering, Stockholm, 2003.

[24] Strategic Plan for the development of the DANUBE RIVER BASIN GIS, Zagreb, 16.02.2004

Figure 22 delineates the **use cases** necessary to differentiate. From top to bottom, the roles within the blue frame (DRB GIS system) successively receive more tools and privileges to change the input of the system. For example, the data input user may access every tool from the user above (the expert user), but not from the user below (e.g. the administrator). A detailed view of the use cases is portrayed in chapters 5.3 (Data handling functions & conversion requirements), 5.4 (Access & Security functions), and 5.5 (WebGIS client functionalities and OGC interfaces).

- **Public User**: any web user who is interested in the condition of the Danube. He/she will be able to view dynamic maps with a WebGIS application (use case: "views public WebGIS"). Querying of the database is integrated, but only "pre-defined", simple queries are available and not the whole content of the DRB GIS database can be viewed (use case: "calls pre-defined queries").
- **Expert user**: this user also has access via the Internet but to gain more information than the public user, special system privileges are provided ("authorized user"). The expert user inherits all user rights from the public user, and the rights are extended to **viewing more complex maps** (use case: "views expert WebGIS") and **querying more information** from the database (use case: "creates advanced queries"). This user has the specialised knowledge to realize when datasets are wrong and can **submit an error message** to the data input user (use case: "submits data errors"). Since this user is interested in creating reports (use case: "creates reports") she/he is usually also has the right (granted by the data input user) to **download data** (use case: "downloads data"). The purpose may be creating the **WFD roof report** (use case: "creates Roof report") or **any other kind of report** (use case: "creates any report").
- **Data input user**: This user's main activity is the delivery of data to the Danube River Basin GIS (use case: "uploads data"). The data input user represents the ICPDR Member States' GIS user who releases the data (and metadata) and who wants to retrieve GIS data from the DRB GIS (use case: "downloads data", inherited from the expert user). Before data upload occurs, schema mapping of national data to the schema of the DRB GIS dataset can be conducted (use case: "maps national data to DRB schema"). After the decision maker has permitted publication, the data input user releases the datasets of her/his country to the public WebGIS (use case: "releases final data version").
- **Administrator**: The administrator is responsible for maintenance of the whole system architecture with all its functions. The installation of users and their associated roles is one of the main tasks of the administrator (use case: "manages users"). She/he is not involved in the thematic content of the portal but in the appropriateness of the web application and the database (use case: "administrates portal").

Outside the DRB GIS:

- **Reconcile user**: This user is a special data input user with extended rights. The institution/person responsible has to be nominated by neighbouring countries. She/he supervises the matching of transboundary datasets and thus has to communicate with national data input users to get commitment to the shared boundary areas (use case: "reconciles data"). The result of the matching process is submitted to the data input user. Since the data input user remains responsible for his/her national data and thus can also reject the reconcile user's suggestion, the reconcile user is an optional role.

> There is one **decision maker** per country who is responsible for the data in a legal sense. The decision maker permits the publication of data sets (Use case: "permits publication"). The data input user can release the final data version at her/his disposition.

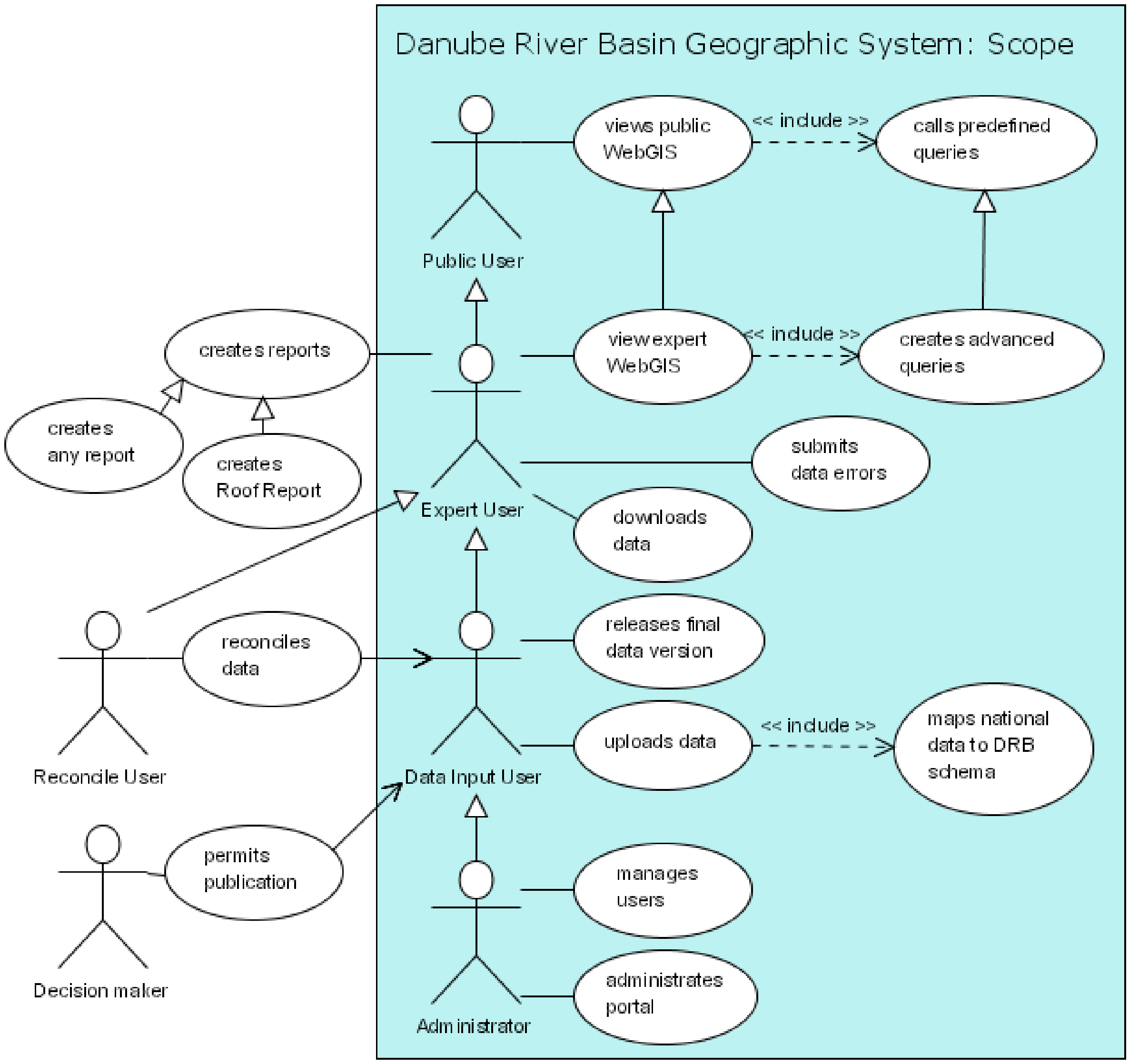


Figure 22: Use cases for DRB GIS

While an information system like the DRB GIS provides a toolkit for information supply, business processes can not be handled solemnly with these tools, but also need support from outside the actual system. The DRB GIS thus provides a variety of different instruments, while the optimal workflow also includes aspects that lie beyond the mere technical solution. In Figure 22, the blue frame comprises the DRB GIS' **system scope**. The decision maker and the reconcile user, however, are working in a national legal framework with strong connection to WFD-reporting. Their main tasks lie outside the actual system, on a higher level of integration (e.g. the role of the reconcile user includes consultation with the national mapping agencies involved).

5.3. Data handling functions & conversion requirements

The geodata format of the DRB GIS is **ESRI shapefile** which is an industry standard for exchanging geodatasets. The Water Framework Directive GIS Guidance Document[25] recognizes ESRI shapefile as a possible format for data provision to the European Commission. The **specification** of ESRI shapefiles is available at http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf (31. 1. 2005).

A shapefile stores nontopological geometry and attribute information for the spatial features in a data set. The geometry for a feature is stored as a shape comprising a set of vector coordinates. Shapefiles support point, line, and area features. Area features are represented as closed loop, double-digitized polygons. Attributes are held in a dBASE® format file. Each attribute record has a one-to-one relationship with the associated shape record. Shapefiles are widely usable, also in software other than ESRI.

The **second geodata format** suggested by WFD GIS Guidance Document is **GML** (Geography Markup Language). This data format was originally specified and is still further developed by the Open Geospatial Consortium. ISO/CD 19136 Geographic information - Geography Markup Language (GML) currently holds the status of "Committee stage", meaning that the standard is still under discussion. Using standards bears the great advantage that the usage (theoretically) is not bound to a special software product.

For the time being, the data exchange format chosen for the DRB GIS is shapefile rather than GML, the main reasons being:

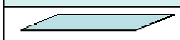
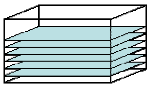
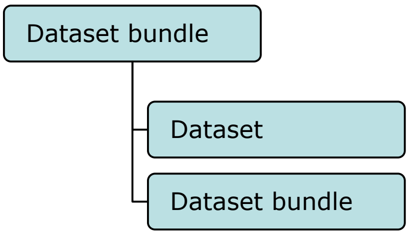
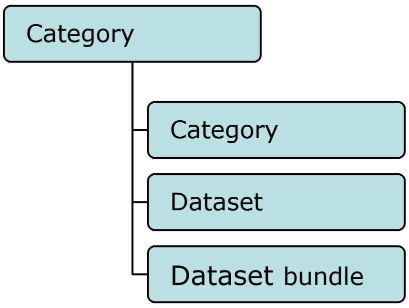
- The **GML 3.1 specification** is very extensive. For being able to work with it, the creation of a so-called profile that contains only the required fields would be necessary.
- ISO 19136 is not published as international standard yet.
- No data available for the Danube river basin are **originally GML**. Therefore, all data would have to be exported from their native format, while some data already are available in shapefile format.
- Due to the fact that not all spatial reference systems are supported, the **export of GML** in GIS software often is problematic. Contrary to that, most GIS software products can **import and export shapefiles**.
- Shapefiles can contain only **one geometry type** which helps to keep the datasets consistent.
- Each web mapping software is able to **display shapefiles**, while GML may differ extremely depending on the XML schema used. Profiles fulfilling the demands of the DRB GIS are not yet available.

[25] Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance Document No 9 Implementing the Geographical Information System Elements (GIS) of the Water Framework Directive. Produced by Working Group 3.1 – GIS. p. 60.

5.3.1. Nomenclature of DRB GIS data

The following table defines the data-related terms used for the DRB GIS system.

Table 13: Nomenclature of DRB GIS data

Dataset	Description
 Single dataset	A single dataset represents the atomic data structure (table, geodataset) of the system which has been uploaded into the system from the data input user. The dataset exists only once in the system, although it can be reused (referenced) multiple times in product bundles and categories.
Dataset bundle	**Description**
 Dataset bundle 	Dataset bundles group at least two items together. A bundle comprises more than one dataset and/or dataset bundle which logically belong together. The term "dataset bundling" does not refer to the physical storing structure, but allows, for example, bundling datasets which are needed for a specific reporting obligation.
Category	**Description**
	The datasets and/or dataset bundles are grouped into categories which provide a hierarchical structure for the portal. A category can contain one ore more subcategories. This structuring mechanism can easily be changed in the future e.g. when more datasets are added, more reporting obligations have to be supported etc. Categories do not reflect the physical data storing structure, but just allow a structured view at the datasets.

Each geodataset is stored in geographic coordinate system and no projection is assigned.

5.3.2. Data download

Only authenticated and authorized users are allowed to download datasets (see chapter 5.4 "Access & Security functions" for details).

Each download dataset consists of a zip file containing:

- **table(s)** in tab delimited format for data not included in shapefile's dbf-file, e.g. 1:n joined data of the DRB GIS database
- **ESRI shape file(s)** containing minimum 3 files for one geodataset with the file extensions *.shp, *.dbf, and *.shx, plus a projection file (*.prj)
- the corresponding **meta data** (*.xml).

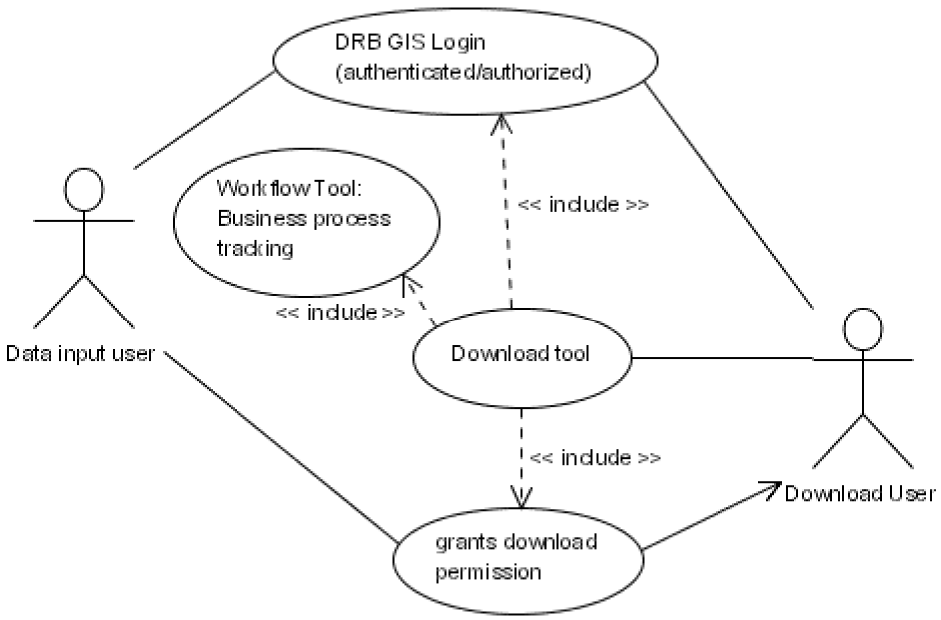


Figure 23: Use case "download data"

Since data ownership is represented by the respective national GIS data input user, only the data input user can grant data download permissions for one or more of his datasets to other users. During a process called "security" (check of authentication and authorization), the system identifies the download user's privileges. If the permission is granted for a category, then all included categories, dataset bundles and datasets are available to the respective user. In the case of granting a dataset bundle, all included dataset bundles and datasets are available (see chapter 5.3.1 "Nomenclature of DRB GIS data"). If the data download user has sufficient rights, he/she receives a link which enables him to download one or more approved data products. The whole business process of downloading data is tracked by the workflow management system that is included in the DRB GIS system (compare chapter 5.3.6 "Workflow management"). This tool provides an overview via a webpage that summarizes which datasets are available for download for the respective user.

Activity diagrams detailing the process of downloading data are available in Annex C.

5.3.3. Data upload

Only authenticated and authorized data input users are allowed to upload datasets, which is accomplished via a web based **data upload tool**. Each geodataset is uploaded as a separate zip file. Tables that are joined to the geodataset in the DRB GIS database have to be included in this zip file. To guarantee consistency in the system, attribute tables should always be uploaded together with the geometry files; only in cases where tables cannot be associated to a geometry, the table can be uploaded on its own.

Each upload dataset consists of a zip file containing:

> **Table(s)** in tab delimited format for data not included in shapefile's dbf-file, e.g. 1:n joined data of the DRB GIS database

> **Maximum one geodataset** as ESRI shape file(s) containing minimum 3 files with the file extensions *.shp, *.dbf, and *.shx, plus a projection file (*.prj). This geodataset is uploaded together with its joined tables.
> the corresponding **meta data** (*.xml).

The geodatasets have to be in geographic coordinate system with no projection. The geographic coordinate systems supported for upload are detailed in Annex D.

The upload process is divided in **three separate steps** that are executed one after another:

> Physical upload of the data zip file to the DRB GIS webserver
> Data validation
> Storage in the DRB GIS system

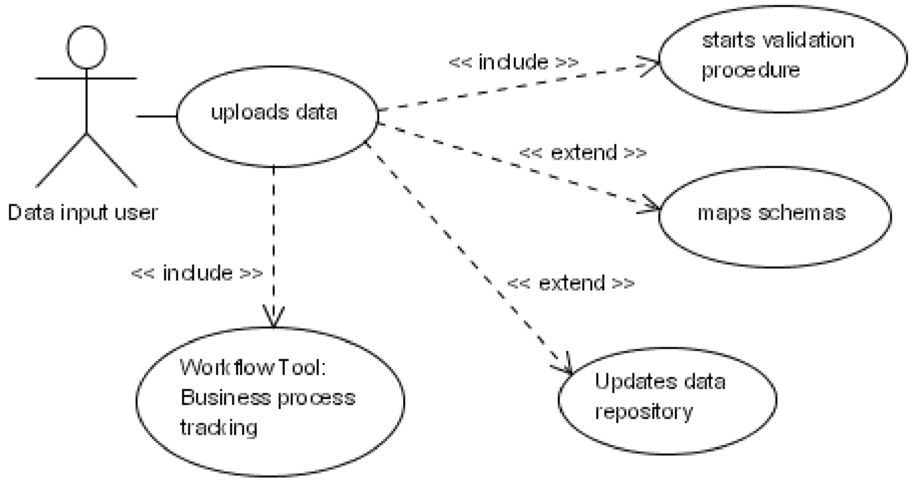


Figure 24: Use case "upload data"

After uploading to the server, the datasets are processed according to the rules of the underlying workflow management system. If the dataset does not conform to the DRB GIS schema, schema mapping has to be applied. Then the datasets are **validated** according to the validation criteria, i.e. the new data are compared to the predefined templates for completeness, for correct fields data types and for the presence of obligatory field values. Furthermore, code checking will be implemented for those datasets where codelists are available. As soon as a dataset of state boundaries has been agreed upon, the incoming data can also be validated concerning their coherence with the state boundaries (data can only be uploaded within the boundaries of the data input user's country, compare chapter 4.3 "Data delivery guidelines").

If the data validation process is completed successfully, data are stored in the DRB GIS system, and any old versions of the uploaded file moved to the DRB GIS data repository. If the dataset does not conform to the DRB GIS standards, the file can is not stored in the system. Regardless of success or failure of the transaction, the outcome of the upload process is submitted to the data input user in form of a status message. If an error occurred, the user is informed why a dataset is not appropriate and what he can do to successfully upload the data next time. If no error occurred, the user is informed of the successful accomplishment of data upload. The business process of uploading is additionally tracked in the workflow management system. Overview is provided by a webpage that summarizes which datasets have been successfully uploaded by which user.

Activity diagrams detailing the process of uploading data are available in Annex C.

5.3.4. Schema mapping - integration operations

One major goal of the DRB GIS is to aggregate datasets from different independent sources into one combined DRB GIS database. For this purpose, **schema mapping** via a web application user interface is required. The integration operations are performed with **wrappers** that basically function as translators between the remote data schema and the common DRB GIS data schema. The result is a database conforming to one schema, thus allowing an integrated view to facilitate attribute querying over the whole Danube river basin.

The wrappers are designed to integrate geodata in the format of ESRI shapefiles. This data format contains several flat files stored in the file system. The content of the dBase file will be wrapped and imported to the DRB GIS server. In the process of matching the given datasets to a common schema, whereupon the wrapper should match only those fields that contain the same data type (e.g. decimal numbers in local schema to decimal numbers in global schema).

The implementation of a schema mapping tool includes the creation of **templates** for the datasets in the master input data list. The templates are used in the prototype phase of the DRB GIS to check system functions and are then provided to all data input users (see also chapter 5.3.5 "Templates for data upload").

To avoid confusion it has to be pointed out that the term "schema mapping" can denominate the mapping of table fields as well as the mapping of table values (record mapping or code translation). Each table consists of records (rows) and fields (columns). The value at the intersection of one row with one column is the cell value. The mapping process can be implemented in two ways:

> Mapping fields by data type and field name
  e.g. field "Name" of the original dataset is mapped to "Basin_Name" in the common database of DRB GIS.

> Mapping values by value ranges (code translation)
  e.g. cell value in original dataset have different value ranges than WFD reporting requires

The mapping of fields by data type and field name will be a standard functionality provided in the DRB GIS. A graphical user interface (GUI) in the DRB GIS portal will allow starting the mapping process.

The creation of a value ranges mapping tool is not foreseen for the first DRB GIS implementation, but may be added later if need be. The requirements of a record mapping tool are:

> providing a user interface with high usability
> programming wrappers for each possible dataset.
> extensive expert knowledge (e.g. knowledge of possible value ranges)

The implementation of a record mapping tool in the first implementation stage of the DRB GIS would require extensive programming efforts and thus is not recommended for now. In later project phases, when all possible data sources have been well documented, value range mapping may prove useful and can be added as an additional tool. For obvious cases (i.e. where codelists are available), however, the checking of values will be integrated in the validation process that takes place in the process of data upload (see chapter 5.3.3 "Data Upload" and Use Cases in Annex C).

5.3.5. Templates for data upload

Apart from schema mapping, the DRB GIS will provide **shapefile templates**, which can be useful e.g. for institutions who produce the required geodatasets for the first time. These templates illustrate what the fields in the common schema of the DRB GIS will look like. Templates for all GIS datasets and DRB GIS database tables will be provided for download. Further on, schema files (xml schema definition file, *.xsd) will be available for offline generation of metadata xml files.

Consequently, there are two major ways to upload data to the DRB GIS:

> Download template and use the national GIS system to fill the shapefiles and tables
> Use the schema mapping tool to adjust national data to the DRB GIS database

As has already been pointed out in connection with the master input data list (chapter 4.4), the creation of so-called working areas for the Danube River Basin is still under discussion. Since the RBM GIS ESG (10^{th} meeting, September 2004 in Zagreb) expressed its strong approval of the implementation of working areas for the Danube, an appropriate field will be foreseen in the templates.

5.3.6. Workflow management

A workflow defines how the participants in a business process work together to execute a process from start to finish; the term workflow thus denotes a series of related interactions between people and a computer system. A tool used for keeping track of the process (i.e. maintaining the state of process executions) is the workflow management system (WFMS).

Business processes, expressed in activity diagrams, serve as input for the development of a workflow management tool. Tracking business processes via workflow management gives both much more control on how the DRB GIS system is working, and on how effectively it is able to support e.g. data harmonization.

Business processes that are tracked in DRB GIS workflow management system are:

> Data download
> Data upload
> Schema mapping

The workflow management system will be a software component within the DRB GIS. It takes as input a formal description of business processes according to the system specification and monitors the state of processes executions. By showing who has done what and when, the WFMS allows tracking e.g. the data upload or reconciling processes and reproduces the actions of the persons responsible in a transparent and reliable way. Furthermore, the implementation of a WFMS allows changing the workflow, like for example integrating additional actors or processing tasks, in a flexible and cost-effective way.

For the data input user and the expert user the workflow management is visible as a web page summarizing which data are available, and which processes have already been executed. Each ready-to-use dataset in this webpage is equipped with a hyperlink that leads the user to the metadata file provided upon data upload; the XML-file is transformed to a webpage using a style sheet (eXtensible style sheet, *.xsl).

That way, a quick view on which data are still missing and which are available for the creation of web maps and for querying the attribute data is possible. Only the system administrator may change entries to the workflow management if errors of the IT system occur. In any other case, no manual changes are required.

5.4. Access & Security functions

The process of accessing the DRB GIS web application consist of two steps:

> Authentication

> Authorisation

For **authentication** the user sends her/his username and password. The system allows access if they are recognised as correct or denies access if any of the two components (username or password) is not correct.

Depending on which privileges the user is granted by the system administrator, the user may access the download, upload, query, and webmapping tool. This process is called **authorisation**, because specific users are authorized to access specific system functions. In this chapter, the actors of the DRB GIS are subsumed in roles. Roles own predefined privileges which are explained in fair detail.

As far as data are concerned, the security mechanism can be set on items (category, dataset bundle, bundle) which enables the data owner (data input user) to grant/revoke specific download permission (see chapter 5.3.1 "Nomenclature of DRB GIS data" for further information).

5.4.1. Public user

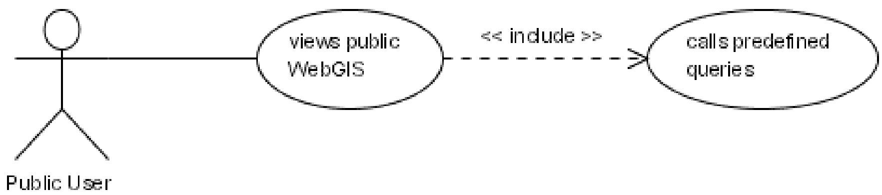


Figure 25: Specific use case(s): public user

The public user is the role of any web user who is interested in the condition of the Danube. He/she is able to view dynamic maps with a WebGIS application. Usability is most important because the user may be neither a GIS- nor a database expert nor provide specialised knowledge about the DRB GIS' content. Querying the database is of course integrated, but only "pre-defined", simple queries are available and not the whole content of the database can be viewed. As the user is not authorized to change any content or to query unapproved datasets, no authentication is necessary. The public user represents the external users especially the public, but also interested institutions of the Danube river basin.

Table 14: Public user: privileges

Role	Privilege to...	Activity
Public user	View public WebGIS	Viewing of predefined maps on the condition of the Danube
Public user	Call predefined queries	Receive answers to specific (predefined) questions concerning the status of the river Danube

5.4.2. Expert user

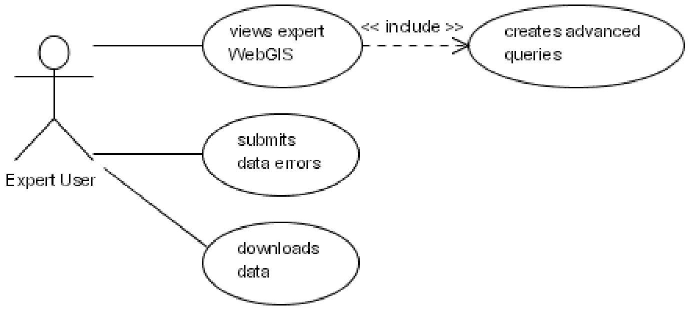


Figure 26: Specific use case(s): expert user

Every user inherits the rights of the user above (in the use case diagram), so every use case accessible for the public user is also available for the expert user. As special system roles are assigned to him (authorized user – login is required), the expert user's rights are extended to viewing more complex maps and retrieving more detailed information from the DRB GIS database. Authentication is therefore obligatory.

The expert user is concerned with creating reports (e.g. the WFD roof report), an activity which is situated outside of the context of DRB GIS and accomplished by using any kind of text processing software. The DRB GIS can, however, support the expert user in compiling this report by allowing the export of web maps as graphics as well as the download of tables. Should the implementation phase substantiate that reporting is needed as an integral part of the DRB GIS system, a reporting tool that puts together text, maps, tables and diagrams can be integrated. For that purpose, further supporting tools would have to be implemented (table formatting tool, diagram tool etc.).

While the data input user is responsible for the upload of data, the system role of the expert user is the provision of expert knowledge for the factual control of data. The expert user is able to recognise data errors which he submits to the data input user who, in turn, has the privileges to change the DRB GIS data.

Table 15: Expert user: privileges

Role	Privilege to...	Activity (authorization required)
Expert user	View Expert WebGIS	Besides predefined web maps, the option to create user defined web maps is available
Expert user	Create advanced queries	Besides predefined queries, the option to create user defined queries is available
Expert user	Submit data errors	Technical data errors are checked during validation process, factual data errors are checked by the expert user who submits them to the data input user
Expert user	Download data	For reporting and other further processing purposes, tabular data, map graphics or geodata (data input user has to grant the rights to do so) may be downloaded

5.4.3. Data input user

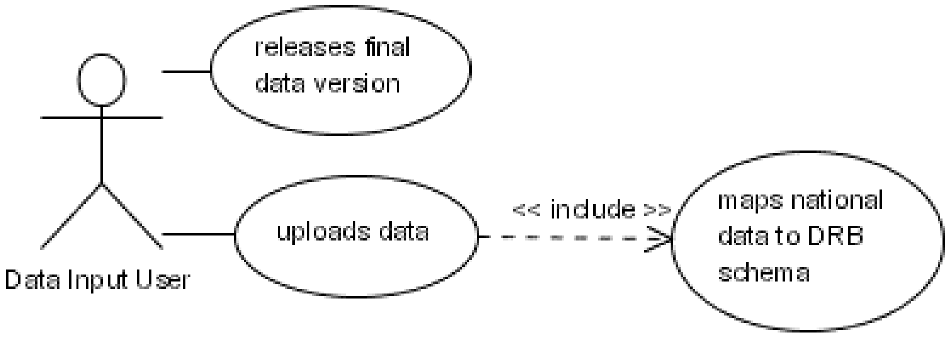


Figure 27: Specific use case(s): Data input user

This user's main activity is to submit data to the DRB GIS. The data input user represents the **ICPDR Member States' GIS user** who delivers the data (and metadata) required for reporting and who wants to retrieve GIS data from the DRB GIS (e.g. EuroGlobalMap). **Validation mechanisms** check whether the uploaded data have any errors and automated feedback is created.

The user role of the data input user needs the privilege to upload data. If the upload of attribute data and geometry datasets is successful, they suit the specific requirements of DRB GIS database. **Schema mapping** allows the automatic "translation" of field names and attributes from national GIS systems. The success or failure during the delivery of datasets to the DRB GIS database will be visible in the workflow management tool which controls the status of the process. Shapefiles uploaded to DRB GIS system are automatically available in the DRB expert WebGIS, while publication for public WebGIS needs permission by the decision maker.

The data input user may update/change only datasets of his own country; for other countries' datasets and maps, only viewing via web map tool and querying via query tool is allowed. As the role representing the owner of the data he/she has uploaded, it is the data input user who grants other users the rights for downloading his/her data.

Table 16: Data input user: privileges

Role	Privilege to...	Activity (authorization required)
Data input user	Uploads data	Upload of geodatasets, tables and metadata to DRB GIS
Data input user	Maps national data to DRB GIS database	Schema mapping may be used if national datasets differ from DRB GIS schema.
Data input user	Releases final data version	After receiving the permission from the decision maker, the final data version is released to the public WebGIS

5.4.4. System administrator

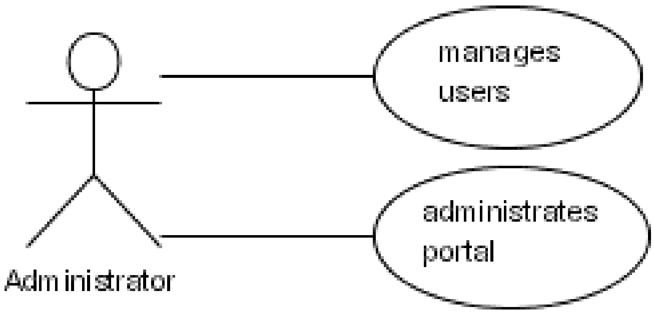


Figure 28: Specific use case(s): system administrator

The administrator is responsible for maintenance of the whole system architecture with all its functions. This user controls the workflow of data input, data change and data commitment by the data input user. Working products are not committed to the public but remain in the secure part of the DRB GIS until the data input user releases and the administrator then commits the final versions to the database. The installation of users and their associated roles is one of the main tasks of the administrator. She/he is not involved in the thematic content of the portal, but in the appropriateness of the web application and the database. The administrator is represented by the GIS manager or one of her/his technical team.

Table 17: System administrator: privileges

Role	Privilege to…	Activity (authorization required)
System administrator	Manages user rights	New users are added only by the system administrator, for each role each country has to nominate one person (where one person can occupy several roles).
System administrator	Administrates portal	All privileges are granted, but only IT-system tasks are fulfilled by the system administrator. This role is not involved in the thematic content of the portal (e.g. checking of data errors) but in the appropriateness of the web application and the database

5.4.5. Decision maker

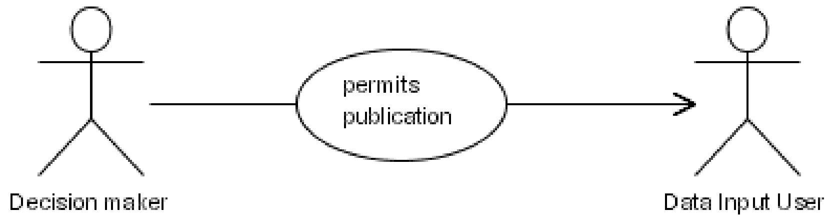


Figure 29: Specific use case(s): decision maker

Outside the DRB GIS system's scope, there is one decision maker per country who is responsible for the data in a legal sense. She/he accepts the results of national GIS data input and the result of reconciling in the Danube River Basin GIS. She/he decides whether data should be made available for the public via WebGIS and querying tools.

Table 18: Decision maker: privileges

Role	Privilege to...	Activity (authorization required)
Decision maker	Permits publication	This person grants the data input user permission to the release of his country's datasets to the public WebGIS.

5.4.6. Reconcile user

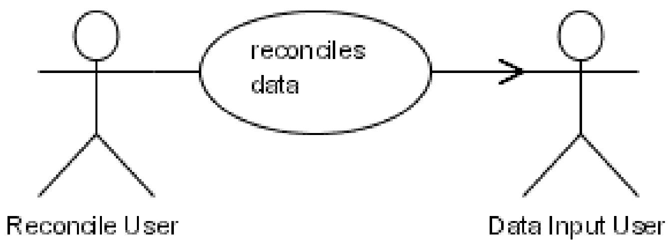


Figure 30: Specific use case(s): reconcile user

This user is a special data input user with extended rights. The institution/person responsible has to be nominated by neighbouring countries for supervising the matching of transboundary datasets. He/She thus has to communicate with national data input users to get commitment to the shared boundary areas. The result of the matching process is submitted to the respective data input user. Since the data input user remains responsible for his/her national data and as such can also reject the reconcile user's suggestion, the reconcile user is an optional role.

Table 19: Reconcile user: privileges

Role	Privilege to…	Activity (authorization required)
Reconcile User	Reconcile data	This person has read/write access to datasets of neighbouring countries. After the matching of boundaries she/he submits the new dataset to the national data input users.

5.4.7. Summary of roles/privileges

Within the system scope, the following privileges are granted:

Table 20: DRB GIS (inside system) - privileges and roles

privileges / roles	view public WebGIS	predefined queries	view Expert WebGIS	advanced querying	Download data	Submit data errors	Upload data	Schema Mapping	release of final data	Manage user	administrate portal
Public User	x	x	---	---	---	---	---	---	---	---	---
Expert User	x	x	x	x	x	x	---	---	---	---	---
Data Input User	x	x	x	x	x	x	x	x	x	---	---
Administrator	x	x	x	x	x	x	x	x	x	x	x

Further privileges necessary for DRB GIS for users outside the system scope:

Table 21: DRB GIS (outside system) - privileges and roles

privileges / roles	privileges of	permit publication	Reconcile data
Reconcile user	Expert User	---	x
Decision maker	Expert User	x	---

5.5. WebGIS client functionalities & OGC interfaces

The DRB GIS will provide two WebGIS clients (public and expert WebGIS) which are based on the same technology and are presented in the same look-and-feel. The toolbox of the expert WebGIS includes more functionality than the public version. In both cases, the WebGIS client's main task is to serve as viewing tool for geographic data.

The graphical user interface includes functions like the following:

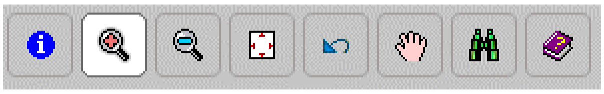


Figure 31: WebGIS – functions

> "Identify" for retrieving database information on geographic objects
> "Zoom in" for enlargement of the current map extent
> "Zoom out" for reduction of the current map extent
> "Zoom to full extent" of Danube river basin
> "Go back" to previous extent
> "Pan" for moving the map extent
> "Search" is the link to the query tool
> "Help" for support

By clicking on the search button, a query mask is provided. The available geodatasets and their attribute data can be limited to those the user is interested in. Depending on the users' privileges, only pre-defined queries are available or the user may additionally define his/her own.

5.5.1. Public WebGIS

Any analysis produced by experts needs specialised knowledge for correct interpretation. Raw data is not suitable for public users who lack factual know-how to understand possible errors or anomalies. Therefore, these users need geoinformation products that minimize the possibility of misinterpretation while offering a maximum of information from soundly pre-processed data.

Apart from the main purpose of the public WebGIS, the viewing of geodatasets in the form of maps, retrieving information from the attribute information is required. Basically, there are two ways to provide the public users with attribute information:

> use the "identify" tool
> use pre-defined queries available in the query tool

The **identify tool** corresponds to a tool included in every GIS software to get information connected to one specific geographic object (e.g. to click on the symbol of a city and thus retrieve e.g. the city name and the number of inhabitants).

Pre-defined queries have to be devised by the system administrator. The result shows information that the public users can easily understand. By using appropriate symbolization and classification, differences and similarities are visible at first sight.

5.5.2. Expert WebGIS

The expert WebGIS looks similar to the public WebGIS but includes more tools to examine the underlying data. The expert user's focus is not on only viewing geographic information and on the visual interpretation of values, but rather on the extraction of information as a basis and illustration e.g. for the creation of reports. The query tool supports the expert user in retrieving specific data in a chosen spatial extent and allows showing the query results as tabular data or in the map window. The possibility of downloading data allows further processing in an extra-DRB GIS-environment (e.g. for statistical analysis).

The extension of the public WebGIS towards the expert version results from the expansion/addition of the following functionalities:

> Expert WebGIS client
> (extended) query tool
> Data download tool

5.5.3. OGC Interfaces

The **Open Geospatial Consortium (OGC)** is an international organization that is leading the development of standards for geospatial and location based services to facilitate interoperability of GIS data. OGC works with private enterprises and governmental and academic institutions to create open and extensible software application programming interfaces for GIS and other mainstream technologies. The specifications are adopted by ISO for the development of international standards (e.g. Web Mapping Service ISO/DIS 19128).

Two OGC services have to be considered in the system definition phase of the DRB GIS:

> Web Mapping Service (WMS)
  http://portal.opengis.org/files/?artifact_id=5316 (31. 1. 2005)
> Web Feature Service (WFS)
  https://portal.opengeospatial.org/files/?artifact_id=7176 (31. 1. 2005)

A **Web Map Service** (WMS) produces an image (e.g. GIF, JPG) of GIS data. The WMS is a protocol that gives clients access to an image (not the features themselves) of geodata via a specially structured http request. In that way, the data can be called into an (GIS) application without being stored on a local hard-disk or network.

If showing georeferenced images is not sufficient, the **Web Feature Service** provides a useful possibility. This service is necessary if the client does not only want to view the images of data, but rather wants to use the actual features (e.g. for analysis and query).

WFS harmonizes the access to data by using a standardized access method:

> Create a new feature instance
> Delete a feature instance
> Update a feature instance
> Get or Query features based on spatial or non-spatial constraints.

Furthermore, the following WFS operations can be carried out:

> GetCapabilities (obligatory)
> GetFeature (obligatory)
> DescribeFeatureType (obligatory)
> Transaction (Insert, Update, Delete) (optional)
> LockFeature (optional)
> GetFeatureWithLock (optional).

Queries are not stated in SQL, but in an OGC XML-based query language called Filter Encoding Implementation Specification.

One of the main advantages of integrating standard interfaces is that they are developed independently of a specific software. If the centralized DRB GIS server incorporates, for example, WMS, the web mapping servers of the participating countries can simply include georeferenced images of these geodatasets in their national webmapping application. In a further DRB GIS development phase, the centralized DRB GIS server can work the other way round: the countries provide their data as WMS service, and the central DRB GIS web mapping server merges these data to one map of the Danube River Basin. If the DRB GIS should be turned into a decentralized system in the future, both OGC interfaces (WMS and WFS) together have to be supported (at least) in a forthcoming DRB GIS project phase.

6. TASK 5: WORKPLAN AND COSTS

6.1. Workplan

The Workplan shown in Annex E assumes the starting time for DRB GIS implementation to be June 2005 (which is considered a realistic date when the responsible parties have come to a decision whether and with whom to implement the DRB GIS and until when financing/contracting matters can be cleared). In case of any delays the finalization of the system will be postponed accordingly.

Until October 2005, a first prototype of the system will be developed, featuring a simple webpage and prototypes of the schema mapping and upload tools that can be tried out with test datasets.

The further development of the system will take place until August 2006, when the DRB GIS should – after a final testing phase – be finished and ready to go online.

Although the three solutions for the DRB GIS differ in the amounts of time required for their implementation, one (medium) development time was assumed for the Workplan. Solutions 1 (COTS) and 2 (Open Source) can require marginally less/more development time respectively.

6.2. Estimation of Costs

To provide an overview as well as the details of the costs the implementation and maintenance of the DRB GIS will generate, Tables 24 and 25 subsume the expected costs while Tables 22 and 23 give details of the person-days and hardware items calculated. Should the system be implemented and maintained at the Umweltbundesamt, considerable discounts to these costs can be given: on the one hand, the Umweltbundesamt has the possibility of acquiring hard- and software components at a reduced price (approx. 30 % off the regular price), and on the other hand, benefits from synergies with the Umweltbundesamt's IT- infrastructure can be profited from. The prices given in the tables below are regular hard- and software prices and personnel costs at a daily rate of € 490 respectively. In addition to the annual costs as shown in Table 25, the replacement of the system's hardware components is due every 3-4 years.

Table 22: DRB GIS System Implementation – Workload (person-days)

WP #	WP Name	Solution 1: COTS	Solution 2: Open Source	Solution 3: Composite
1	Database design and development	73	80	80
1.1	Data modelling & Metadata Schema	25	25	25
1.2	Database installation	1	2	2
1.3	Database programming	12	15	15
1.4	Database tests	2	2	2
1.5	Codelist development	8	8	8
1.6	Shapefile templates development	20	20	20
1.7	Security definition (users, roles, privileges)	5	8	8
2	Application development	185	206	185
2.1	Webmapping server installation	1	1	1
2.2	Webmapping server customization	5	8	5
2.3	Webmapping client public	15	20	15
2.4	Webmapping client expert	30	35	30
2.5	Query tool	20	25	20
2.6	Workflow Management & Tool	15	15	15
2.7	Upload Tool	16	20	16
2.8	Download Tool	18	22	18
2.9	Schema Mapping	20	20	20
2.10	Validation	10	10	10
2.11	Web Portal Programming	10	10	10
2.12	OGC-Interface WMS/ESRI Image Service	10	8	10
2.13	OGC-Interface WFS/ESRI Feature Service	15	12	15
3	Project management	35	35	35
3.1	Quality assurance	5	5	5
3.2	Documentation	5	5	5
3.3	Coordination	15	15	15
3.4	Meetings	10	10	10
4	Rollout	32	32	32
4.1	System Testing & Refinement	12	12	12
4.2	User training & Training preparation	5	5	5
4.3	System Architecture Documentation	10	10	10
4.4	Technical Helpdesk for ICPDR	5	5	5
	Sum	325	353	332

WP … work package

the 3 solutions in comparison:

blue: lowest figures (least person-days required)

red: highest figures (most person-days required)

grey background: same figures in all 3 solutions

Table 23: Hardware Specification[26]

Quantity	Item	Costs (€)[27]
	Data Server	€ 7,372
1	ProLiant DL380 G3 Xeon/3,0 (512KB, 1024MB, 1P)	2,351
1	HP 2GB REG PC2-3200 2x1GB DDR Memory	1,025
2	Harddisk 36GB 15K RPM Ultra 320 Hot-Plug	528
2	Harddisk 146GB 10K RPM Ultra 320 Hot-Plug	1,184
2	Redundant Fan (Hot-Plug) for DL380G3	346
2	Hot Plug red Pwr Supply for DL380G4	382
1	Integrated Lights-Out Advanced Pack	323
1	Battery Backed Write Cache Enabler Option Kit	173
1	Assembling	100
1	Service & Support (3 years)	960
	Application Server	€ 7,134
1	ProLiant DL380 G3 Xeon/3,0 (512KB, 1024MB, 1P)	2,351
1	HP 2GB REG PC2-3200 2x1GB DDR Memory	1,025
2	Harddisk 72GB 10K RPM Ultra 320 Hot-Plug	634
2	Harddisk 36GB 15K RPM Ultra 320 Hot-Plug	528
2	Redundant Fan (Hot-Plug) for DL380G3	346
2	Hot Plug red Pwr Supply for DL380G4	382
1	Integrated Lights-Out Advanced Pack	323
1	Dual Channel U320 SCSI Host Bus Adapter	312
1	Battery Backed Write Cache Enabler Option Kit	173
1	Assembling	100
1	Service & Support (3 years)	960
	Rack	€ 6,161
1	Universal Rack 10642 (42U) Rack Cabinet	1,284
1	Universal Rack Option: Rack 10000 Stabilizer Kit 600mm	168
1	Universal Rack Option: Rack 10642 Side Panel 42U	281
1	Universal Rack Option: Rack 10000 Blanking Panels, 1U (10 pcs.)	45
2	USV R3000 XR	2,966
2	Rack Power Distribution Unit (PDU) Kit 16A (includes 1x Controller Unit and 2x Extension Bars)	514
1	Monitor 17"	199
1	KVM switch	560
2	Connecting cables	90
1	Keyboard + Mouse	54
	Backup System	€ 3,300
1	HP Storage Works 1/8 TAPE Autoloader DLT	2,500
1	Service & Support (3 years)	800

[26] all prices as of January 2005, excl. VAT

[27] Should the Umweltbundesamt implement the system and acquire the hardware, prices are approximately € 4,600 (data server), € 4,500 (application server), € 5,000 (rack), € 3,100 (backup system). (The Umweltbundesamt has the possibility to acquire hard- and software at a considerably reduced price.)

Table 24: DRB GIS Cost Estimation – Implementation [28]

Item	Solution 1: COTS (€)	Solution 2: Open Source (€)	Solution 3: Composite (€)
Personnel[29]	159,250	172,970	162,680
Hardware[30]	23,967	23,967	23,967
Data Server	7,372	7,372	7,372
Application Server	7,134	7,134	7,134
Rack[31]	6,161	6,161	6,161
Backup System[32]	3,300	3,300	3,300
Software	22,225	8,100	17,800
Operating System for 2 Servers	1,420	1,420	1,420
Oracle 10g Standard Edition One	4,705	n/a	n/a
mySQL 4.1.7	n/a	free	free
ESRI ArcIMS	10,700	n/a	10,700
Deegree/GeoServer	n/a	free	n/a
Apache HTTP Server	free	free	free
Jakarta Tomcat	free	free	free
Jboss jBPM	free	free	free
Java Server Pages	free	free	free
Backup System[33]	1,400	680	680
Software Installation	4,000	6,000	5,000
Travel Expenses[34]	5,000	5,000	5,000
Sum (rounded)	€ 210,500	€ 210,000	€ 209,500

Optional: Data Preparation[35] (25 person-days)	**€ 12,250**

[28] all prices as of January 2005, excl. VAT

[29] according to person-days detailed in Table 22, daily rates € 490. Costs are calculated according to different types of experts involved (expert, senior expert, supervising expert).

[30] according to prices detailed in table 23. The lifecycle of the hardware technology is calculated with 4 years; after that period, the hardware should be replaced.

[31] Should the system be implemented at the Umweltbundesamt, the DRB GIS hardware can be integrated to the Umweltbundesamt's infrastructure, which results in less costs for the rack.

[32] Should the system be implemented at the Umweltbundesamt, the Umweltbundesamt's backup system can be used for solutions 1 and 3. For solution 2, the backup hardware listed here has to be acquired in any case.

[33] Should the system be implemented at the Umweltbundesamt, the costs for backup software amount to € 280,- (€ 140 per server) for all three solutions

[34] estimation (5 meetings during system implementation)

[35] The preparation of the data already available (i.e. those used for the Roof Report 2004) to meet the DRB GIS needs is essential for the system's success. As data preparation is however not an integral part of the development of the system, it is included as an optional matter of expense here. The preparation of Roof Report 2004-data includes: 1. combination of data to generate datasets as described in Annex A, 2. conversion to defined reference system & projection, 3. correction of major topological errors, 4. adaptation of attributes to conform to DRB GIS schema, 5. creation of metadata for each dataset. Additionally, data mining and the download and adaptation of freely available data that can also be useful for the DRB GIS is included (e.g. geology, DEM)

Table 25: DRB GIS Cost Estimation – Maintenance (per year)[36]

Item[37]	Solution 1: COTS		Solution 2: Open Source		Solution 3: Composite	
	days[38]	costs (€)	days	costs (€)	days	costs (€)
Software[39]		**3,950**		**420**		**2,620**
Operating System[40]		300		300		300
Oracle 10g[41]		~ 1000		n/a		n/a
ESRI ArcIMS[40]		2,200		n/a		2,200
Backup System		~ 450		~ 120		~ 120
System Administration	**78**	**38,220**	**98**	**48,020**	**82**	**40,180**
Operating System & DBMS[42]	36	17,640	44	21,560	36	17,640
Application	30	14,700	36	17,640	32	15,680
Backup	12	5,880	18	8,820	14	6,860
Domain[43]		**20**		**20**		**20**
Sum (rounded)		**€ 42,200**		**€ 48,500**		**€ 42,800**

6.3. BenefitS & Risks

Benefits

The implementation of a DRB GIS provides many advantages for the ICPDR, its expert bodies and Member States, for decision makers as well as for the general public. Some advantages of the system have already been pointed out in chapter 2.2 (System Scope and System Restraints); the most important "general" benefits with regards to WFD implementation and other reporting obligations are listed in the following.

> The institutionalisation of data harmonization processes and the establishment of common standards are vital for the creation of high-quality and consistent data in a common Danube database.

> A common database and thus consistent information increases the awareness about the status of waters in the DRB and is a prerequisite for good planning and reporting practice at a basin wide level.

[36] all prices as of January 2005, excl. VAT

[37] 3 year's hardware maintenance by the hardware provider is included in the respective hardware prices (see table 23); for each further year, additional costs of e.g. ~€ 300/sever occur (the servers should, however, be replaced every 3-4 years)

[38] person-days per year (daily rates € 490)

[39] service contracts with software providers (software assurance); includes upgrades to new versions (releases)

[40] from the second year after purchase onwards (first year's maintenance is covered by software warranty); should the system be implemented at the Umweltbundesamt, the costs amount to ~ € 140,-/year.

[41] from the second year after purchase onwards (first year's maintenance is covered by software warranty)

[42] Database Management System

[43] annual costs for an Internet Domain, e.g. "www.danubegis.org"

> The creation of a common methodology for bilateral/multilateral data harmonization does not only facilitate the creation of a common Danube database, but also supports data sharing and helps to improve communication and sharing expertise between GIS users in the DRB. Furthermore, executives' and policy-makers' GIS knowledge and skills are increased and the opportunities and benefits of the technology become evident.
> As the system caters for different user needs (e.g. GIS experts as well decision makers unfamiliar with the technology), and the medium "Internet" guarantees easy access to the data, a better information flow and improvements in the decision-making process can be obtained.
> The system guarantees continuity for recurrent (reporting) obligations. As all data and existing products should be linked to or included in the system, duplicate efforts can be avoided and money saved. While the preparation of the first harmonized database will require some extra effort from the ICPDR Member States' GIS experts, the system can facilitate future work.
> Most importantly, the system fulfils the WFD requirement of public information dissemination. A DRB GIS provides information on the situation of the Danube River via a tool that can be accessed by a large majority of the population, that is up-to-date and easily understandable.

Risks

Several factors could jeopardize the successful implementation and maintenance of the DRB GIS system. By awareness and allowing for mitigating factors, these risks can be minimized.

> The DRB GIS has to cater for several stakeholders who operate on multiple levels (national and international) and are geographically dispersed. Adequate communication with all actors involved needs to be taken care of; decision-making processes can be quite complex and require a fair amount of time. It is thus important that the timeframe is not calculated to tightly and that communication canals are defined clearly. The project team installed for the system definition phase (consisting of a representative of the ICPR, the GEF/DRP, the GIS ESG and the Umweltbundesamt) proved to be a good forum and should be established in a similar form for system implementation.
> Since several parties' interests have to be taken into account, the overall complexity of the DRB GIS system is rather high. The implementation of a basic system that can later be expanded to cater, for example, for further ICPDR expert group's needs, appears to be the best approach.
> Financing the system might prove a complex matter; most probably, costs will be covered from different sources. Although system implementation in several steps is possible, it should be taken care of that the implementation process is not ripped into too many parts that complicate the process and lead to duplicate or even multiple efforts. Even more importantly, the whole system can become obsolete quite quickly when not maintained properly: adequate system maintenance is one of the crucial points for a successful DRB GIS and must not be underestimated. The coverage of system maintenance costs has to be guaranteed.
> Legal obstacles as concerns data harmonization could occur. Solutions have to be found in coordination with the experts and authorities concerned. Data problems (lack or minor quality of data) can be a problem for the system's success. The data already available can function as a basis, but it is the ICPDR Member States' task to further build up on that basis and enhance the system with better data whenever possible.

- Technological risks for the DRB GIS solutions making use of commercial products (solutions 1 and 3) are low. All products planned are used widely and have proven to be able to provide the functions required; their ongoing development is guaranteed. As for the Open Source products (solution 2 mainly), their development cannot be foreseen. The technological risk is much higher here.
- The risk that the final product does not live up to the user's expectations should be mitigated with recurrent circles of user input and feedback, as has already been practiced for the system definition phase.

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ANNEXES

ANNEX A Master input data list

ANNEX B Metadata

ANNEX C use cases

ANNEX D supported geographic coordinate systems

ANNEX E Workplan

ANNEX A: MASTER INPUT DATA LIST

ANNEX A: MASTER INPUT DATA LIST

Table 1: Geodata list

Description of Geodatalist fieldnames:

geodata_id	unique identifier for geodata set (same geodata_set could be defined in different scales)
geodata_set	name of geodata_set
geodata_description	description of geodata set
max_scale	maximum scale denominator for display on a map (this large the data presentation makes sense)
opt_scale	optimal scale denominator for display on a map
min_scale	minimum scale denominator for display on a map (this small the data presentation makes sense)
geodata_type	geodata type shape, raster, …
geodata_def	geodata definition: shape: polygon, point, line, annotation; raster: raster
table_include	is there a link to a table: y = yes, n = no

Display scale is a data set property that gives information in which range a dataset should be displayable. The individual datasets' scales of origin will be stored in the Metadata tables. The individual datasets' scales of origin should be in the range from min_scale to max_scale and if available they should be near the opt_scale. The scale values given are the target that should be reached. Scales in the existing data sets still differ (often considerably) from these scales. Only for widely available data sets (e.g. CORINE Landcover 250m) the values for scale were taken from the dataset itself.

geodata_set	geodata_description	max_scale	opt_scale	min_scale	geodata_type	geodata_def	table_include
State	State polygons	100000	250000	1000000	shape	polygon	y
AdminBound	Administrative Boundaries	100000	250000	1000000	shape	line	y
AdminEntit	Administrative Entities	100000	250000	1000000	shape	polygon	y
Cities_p	Cities	100000	250000	1000000	shape	point	y
Cities_a	Extensive cities (have to be presented as areas)	100000	250000	1000000	shape	polygon	y

geodata_set	geodata_description	max_scale	opt_scale	min_scale	geodata_type	geodata_def	table_include
Settlement	Settlement Area	100000	250000	1000000	shape	polygon	y
RBD	River basin district Danube	100000	250000	1000000	shape	polygon	y
Rivbasin	Riverbasins and Subbasins (=large catchment areas)	100000	250000	1000000	shape	polygon	y
Catchment	River catchment areas (for all rivers down to a defined size)	100000	250000	1000000	shape	polygon	y
Compauth	Location of competent authorities for WFD in the DRBD	100000	250000	1000000	shape	point	y
CWbody	Coastal Waters	100000	250000	1000000	shape	polygon	y
GWbody	Groundwater Body	100000	250000	1000000	shape	polygon	y
RWseg	River Segments - can be combined to RiverWaterBodies	100000	250000	1000000	shape	line	y
RWseg_a	River Segments - impoundment (the centerline is in RWseg)	100000	250000	1000000	shape	polygon	y
LWseg	Lake Segments - can be combined to LakeWaterBodies	100000	250000	1000000	shape	polygon	y
TWbody	TransitionalWaterBody	100000	250000	1000000	shape	polygon	y
GWstn	Groundwater Monitoring Station	100000	250000	1000000	shape	point	y
SWstn	Surface Water Monitoring Station	100000	250000	1000000	shape	point	y
Ecoreg	Ecoregions in the DRBD	100000	250000	1000000	shape	polygon	y
PAbird	Bird protection area	100000	250000	1000000	shape	polygon	y
PAdrinkWat	Drinking water protection areas	100000	250000	1000000	shape	polygon	y
PAhabitat	Habitat protection area (FFH)	100000	250000	1000000	shape	polygon	y
PAnutritie	Nutritient-sensitive areas	100000	250000	1000000	shape	polygon	y
PAsignSpec	Economically significant aquatic species protection areas	100000	250000	1000000	shape	polygon	y

geodata_set	geodata_description	max_scale	opt_scale	min_scale	geodata_type	geodata_def	table_include
PArecreati	Recreational waters	100000	250000	1000000	shape	polygon	y
Wetland	Major wetlands in the DRBD	100000	250000	1000000	shape	polygon	y
RiskSpot_p	Potential risk spots for accidents	100000	250000	1000000	shape	point	y
RiskSpot_a	Extensive Potential risk spots for accidents(have to be presented as areas)	100000	250000	1000000	shape	polygon	y
ContSite_p	Contaminated sites	100000	250000	1000000	shape	point	y
ContSite_a	Contaminated sites (have to be presented as areas)	100000	250000	1000000	shape	polygon	y
PointSourc	Main point sources of pollution in the DRBD	100000	250000	1000000	shape	point	y
Harbour	Important harbours in the DRBD	100000	250000	1000000	shape	point	y
HydroStruc	Hydraulic structures (e.g. dam, weir, sluice, outlet)	100000	250000	1000000	shape	point	y
Topography	Topographic annotations in the DRBD	100000	250000	1000000	shape	annotation	n
DEM	Digital Elevation Model - SRTM 90	100000	250000	1000000	raster	raster	n
Hillshade	Hillshaded Digital Elevation Model (cartographically revised)	100000	250000	1000000	raster	raster	n
Geology	Geologic overview of the DRBD	1000000	5000000	10000000	shape	polygon	y
Landuse	Landuse - PELCOM 1 km	250000	1000000	10000000	raster	raster	n
Landuse	Landuse - CORINE 250 m	100000	500000	50000000	raster	raster	n
Precipitat	Overview precipitation of the DRBD	250000	1000000	10000000	raster	raster	n

Table 2: Tables

Description of Tables fieldnames:

table_name name of the table – corresponds to geodata set

table_ID unique identifier for table (max. 10 characters)

table_desc table description

No classification tables for rasters are included at the moment.

table_ID	table_name	table_desc
1	Metadata	Metadata
2	State	State description codes and parameters
3	AdminBound	Codes for administrative boundaries
4	AdminEntit	Names and codes for administrative entities
5	Cities	City codes and parameters
6	Settlement	Settlement Area
7	RBD	River basin district
8	Rivbasin	River basins
9	Catchment	Catchments
10	Compauth	Competent Authorities
11	CWbody	CoastalWaterBodies
12	GWbody	GroundWaterBodies
13	RWbody	RiverWaterBodies - Link to RWseg
14	River	Rivers - Link to RWseg
15	RWseg	River segments
16	LWbody	LakeWaterBodies - Link to LWseg
17	LWseg	Lake segments
18	TWbody	Transitional Water Bodies
19	GWstn	Groundwater Monitoring Stations
20	SWstn	Surface Water Monitoring Stations
21	Ecoreg	Ecoregions
22	Protarea	Protected Areas
23	Wetland	Wetlands
24	RiskSpot	Accident Risk Spots
25	ContSite	Contaminated Sites
26	PointSourc	Point Sources
27	Harbour	Harbours
28	HydroStruc	Hydrologicals Structures
29	Geology	Geology

Table 3: Attributes

Important: This is a first draft of the attributes list! The more detailed data modelling will be accomplished during the main design phase.

Description of Attributes fieldnames:

field_id	unique identifier for table field
table_id	link to the table to which the field belongs (key to table_ID in tables table)
attribute_name	name of the attribute
field_name	name of the field (max. 10 char)
field_type	field type
length	length of the field
attribute_desc	description of the attribute
possible_values	values that can be filled in – if empty there is a wide range of possible values
keytofield	foreign key to another table (linkedtable)
linkedtable	the table that is linked via foreign key (keytofield)

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
1	1	Identificator	ID	number	24	Unique identifier for features in data set			
2	1	MetadataID	META_ID	string	24	Unique code for Metadata			
3	1	MetadataPath	META_NAME	string	100	Name of Metadata XML-File			
4	2	Identificator	ID	number	24	Unique identifier for features in data set			
5	2	Name	NAME	string	30	name of the state			

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
6	2	StateNameCode	ISO3166	string	2	state names ISO3166	<<code list>> ISO3166		
7	2	PartOfDRBD	DRBD	string	1	shows if state has part of DRBD	{Y = part of the DRBD, N = no part of the DRBD}		
8	2	AreaKM2	AREAKM2	number	6,2	official size of the state in sqkm			
9	2	Capital	CAPITAL	string	24	Capital City		CTY_CD	Cities
10	2	Government_Seat	GOVERNMENT	string	24	Government Seat		CTY_CD	Cities
11	2	ICPDR_Status	ICPDR	string	20	member status in ICPDR	{FM = full member, AM = associated member, NM = no member}		
12	2	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata
13	3	Identificator	ID	number	24	Unique identifier for features in data set			
14	3	MetadataID	META_ID	string	24	Unique code for Metadata			
15	3	BoundaryType	BND_TYPE	string	6	Code for type of administrative Boundary (e.g. state boundary, province boundary, district boundary)	{level0 = state boundaries, level1 = boundaries of first level of administrative entities in a state, level2 = boundaries of second level of administrative entities, level3 = boundaries of third level of administrative entities, .)		
16	4	Identificator	ID	number	24	Unique identifier for features in data set			
17	4	Name	NAME	string	100	Locally used name for administrative entity			

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
18	4	AdminEntityCode	AE_CODE	string	24	Code for administrative entity			
19	4	AdminEntityLevel	AE_LEVEL	string	2	Level of administrative Entity	{level0 = state, level1 = first level of administrative entities in a state, level2 = second level of administrative entities, level3 = third level of administrative entities, ...)		
20	4	MetadataID	META_ID	string	24	Unique code for Metadata			
21	5	Identificator	ID	number	24	Unique identifier for features in data set			
22	5	Name	NAME	string	100	name of the city			
23	5	CityCode	CTY_CD	string	24	Unique code for city			
24	5	Inhabitants	CTY_INHAB	number	8	inhabitants of the city			
25	5	MetadataID	META_ID	number	24	Link to Metadata		META_ID	Metadata
26	7	Identificator	ID	number	24	Unique identifier for features in data set			
27	7	Name	NAME	string	100	Locally used name			
28	7	MSCode	MS_CD	string	22	Unique code for a river basin district within MS	As per coding guidelines		
29	7	EuropeanCode	EU_CD	string	24	Unique code for a river basin district at EU level	As per coding guidelines		
30	7	CompetentAuth	AUTH_CD	string	24	Code of the competent authority for the RBD		AUTH_CD	Compauth
31	7	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
32	8	Identificator	ID	number	24	Unique identifier for features in data set			
33	8	Name	NAME	string	100	Locally used name for River basin			
34	8	MSCode	MS_CD	string	22	Unique code for a river basin within MS	As per coding guidelines		
35	8	EuropeanCode	EU_CD	string	24	Unique code for a river basin at EU level	As per coding guidelines		
36	8	DistrictCode	DIST_CD	string	24	Code for River Basin District the basin belongs to		EU_CD	RBD
37	8	AreaKM2	AREAKM2	number	6	Area in square kilometres			
38	9	Identificator	ID	number	24	Unique identifier for features in data set			
39	9	CatchmentName	NAME	string	100	Locally used name of a Catchment			
40	9	CatchmentCode	CAT_CD	string	24	Unique code for river catchment			
41	9	RBDCode	RBD_CD	string	24	Code of the RBD the Catchment belongs to		MS_CD	RBD
42	9	MetadataID	META_ID	string	24	Unique code for Metadata			
43	10	Identificator	ID	number	24	Unique identifier for features in data set			
44	10	Name	NAME	string	100	Locally used name			
45	10	Address	ADDRESS	string	200	Correspondence Address			
46	10	AuthorityCode	AUTH_CD	string	24	Unique code for the competent	To be defined		

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
						authority.			
47	10	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata
48	11	Identificator	ID	number	24	Unique identifier for features in data set			
49	11	Name	NAME	string	100	Locally used name			
50	11	MSCode	MS_CD	string	22	Unique code for a waterbody within MS	As per coding guidelines		
51	11	EuropeanCode	EU_CD	string	24	Unique code for a waterbody at EU level			
52	11	EcoRegionCode	REGION_CD	string	2	Ecoregion to which a waterbody belongs	As per coding guidelines	REGION_CD	Ecoreg
53	11	System	SYSTEM	string	1	Type of characterization of a waterbody	{A, B}		
54	11	InsertedWhen	INS_WHEN	date	14	Moment of insertion in the database	YYYYMMDDhhmmss		
55	11	InsertedBy	INS_BY	string	15	Acronym of operator			
56	11	RiverBasinCode	BASIN_CD	string	24	The code of the parent river basin (see coding system)		EU_CD	RivBasin
57	11	StatusYear	STATUS_YR	string	4	Year of reporting of waterbody characterisation			
58	11	HeavilyModified	MODIFIED	string	1	Whether the waterbody is heavily modified	{Y, N}		
59	11	Artificial	ARTIFICIAL	string	1	Whether the waterbody is artificial	{Y,N}		
60	11	SalinityTypology	SALINITY	string	1	Salinity category according to	{F = Freshwater, O =		

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
						Annex II	Oligohaline, M = Mesohaline, P = Polyhaline, E = Euhaline}		
61	11	DepthTypology	DEPTH_CAT	string	1	Depth category based on mean depth	{S = Shallow <30m, I = Intermediate 30-200m, D = Deep >200m}		
62	11	*Latitude*	LAT	number	8,5	Definition not given in WFD. Assume Latitude (in ETRS89) of mathematical centre of waterbody	Can be calculated from supplied geometry		
63	11	*Longitude*	LON	number	8,5	Definition not given in WFD. Assume Longitude (in ETRS89) of mathematical centre of waterbody	Can be calculated from supplied geometry		
64	11	*TidalTypology*	TIDAL	string	5	Not defined – assume same as Transitional Tidal range category according to Annex II	{MICRO, MESO,MACRO}		
65	11	MetadataID	META_ID	number	24	Link to Metadata		META_ID	Metadata
66	12	Identificator	ID	number	24	Unique identifier for features in data set			
67	12	Name	NAME	string	100	Locally used name			
68	12	MSCode	MS_CD	string	22	Unique code for a waterbody within MS	As per coding guideline		
69	12	EuropeanCode	EU_CD	string	24	Unique code for a waterbody at EU level	As per coding guidelines.		
70	12	EcoRegionCode	REGION_CD	string	2	Ecoregion to which a		REGION_CD	Ecoreg

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
						waterbody belongs			
71	12	InsertedWhen	INS_WHEN	date	14	Moment of insertion in the database	YYYYMMDDhhmmss		
72	12	InsertedBy	INS_BY	string	15	Acronym of operator			
73	12	RiverBasinCode	BASIN_CD	string	24	The code of the parent river basin (see coding system)		EU_CD	RivBasin
74	12	Horizon	HORIZON	number	2	Unique identifier for the horizon, where separate, overlying bodies exist			
75	12	StatusYear	STATUS_YR	string	4	Year of reporting of waterbody characterisation			
76	12	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata
77	13	Identificator	ID	number	24	Unique identifier for features in data set			
78	13	Name	NAME	string	100	Locally used name	As per coding guidelines		
79	13	MSCode	MS_CD	string	22	Unique code for a waterbody within MS			
80	13	EuropeanCode	EU_CD	string	24	Unique code for a waterbody at EU level	As per coding guidelines		
81	13	EcoRegionCode	REGION_CD	string	2	Ecoregion to which a waterbody belongs		REGION_CD	Ecoreg
82	13	System	SYSTEM	string	1	Type of characterization of a waterbody	{A, B}		
83	13	InsertedWhen	INS_WHEN	date	14	Moment of insertion in the database	YYYYMMDDhhmmss		

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
84	13	InsertedBy	INS_BY	string	15	Acronym of operator			
85	13	RiverBasinCode	BASIN_CD	string	24	The code of the parent river basin (see coding system)		EU_CD	RivBasin
86	13	StatusYear	STATUS_YR	string	4	Year of reporting of waterbody characterisation			
87	13	HeavilyModified	MODIFIED	string	1	Whether the waterbody is heavily modified	{Y, N}		
88	13	Artificial	ARTIFICIAL	string	1	Whether the waterbody is artificial	{Y,N}		
89	13	AltitudeTypology	ALT_CAT	string	4	Altitude category according to Annex II	{HIGH, MID, LOW}		
90	13	GeologyTypology	GEOL_CAT	string	1	Geological category according to Annex II	{C = Calcareous, S= Siliceous, O = Organic}		
91	13	SizeTypology	SIZE_CAT	string	2	Size based on catchment area according to Annex II	{S,M,L,XL}		
92	13	Continua	CONTINUA	string	1	Whether river segment is an imaginary link segment to maintain network topology	{Y, N}		
93	13	FlowDirection	FLOWDIR	string	1	Flow direction with respect to digitized direction	{W = With, A = Against}		
94	13	*Latitude*	LAT	number	8,5	Definition not given in WFD. Assume Latitude (in ETRS89) of mathematical centre of waterbody	Can be calculated from supplied geometry		
95	13	*Longitude*	LON	number	8,5	Definition not given in WFD. Assume Longitude (in ETRS89)	Can be calculated from supplied geometry		

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
						of mathematical centre of waterbody			
96	13	*Geology*	GEOLOGY			Not defined			
97	13	*SizeMeasurement*	SIZE			Not defined			
98	13	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata
99	14	Identificator	ID	number	24	Unique identifier for features in data set			
100	14	Name	NAME	string	100	river name			
101	14	MSCode	RIV_CD	number	24	unique river code			
102	14	LengthKM	LENGTHKM	number	6,2	official length of the river			
103	14	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata
104	15	Identificator	ID	number	24	Unique identifier for features in data set			
105	15	SegmentCode	SEG_CD	string	24	Unique code for the segment			
106	15	RWB_Code	RWB_CD	string	24	Unique code of RiverWater Body to which this segment belongs		EU_CD	RWbody
107	15	River_Code	RIV_CD	string	24	Unique code of River to which segment belongs		RIV_CD	River
108	15	Name	NAME	string	100	Locally used name			
109	15	Continua	CONTINUA	string	1	Wheter river segment is an imaginary link segment to maintain network topology (e.g. imaginary rivers through lakes)	{Y,N}		

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
110	15	FlowDirection	FLOWDIR	string	1	Flow direction with respect to digitized direction	{W = With, A = Against}		
111	15	WaterwayClass	WATERWAY	string	3	Classification of European Inland Waterways (ECE/TRANS/SC.3/131)	{IV, Va, Vb, VIa, VIb, VIc, VII}		
112	15	BoundaryType	BND_TYPE	string	6	Code for type of administrative Boundary (e.g. state boundary, province boundary, district boundary) that is part of the RWseg	{level0 = state boundaries, level1 = boundaries of first level of administrative entities in a state, level2 = boundaries of second level of administrative entities, level3 = boundaries of third level of administrative entities, ..)	BND_TYPE	AdminBound
113	15	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata
114	16	Identificator	ID	number	24	Unique identifier for features in data set			
115	16	Name	NAME	string	100	Locally used name			
116	16	MSCode	MS_CD	string	22	Unique code for a waterbody within MS	As per coding guidelines		
117	16	EuropeanCode	EU_CD	string	24	Unique code for a waterbody at EU level	As per coding guidelines		
118	16	EcoRegionCode	REGION_CD	string	2	Ecoregion to which a waterbody belongs		REGION_CD	Ecoreg
119	16	System	SYSTEM	string	1	Type of characterization of a waterbody	{A, B}		

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
120	16	InsertedWhen	INS_WHEN	date	14	Moment of insertion in the database	YYYYMMDDhhmmss		
121	16	InsertedBy	INS_BY	string	15	Acronym of operator			
122	16	RiverBasinCode	BASIN_CD	string	24	The code of the parent river basin (see coding system)		EU_CD	RivBasin
123	16	StatusYear	STATUS_YR	string	4	Year of reporting of waterbody characterisation			
124	16	HeavilyModified	MODIFIED	string	1	Whether the waterbody is heavily modified	{Y, N}		
125	16	Artificial	ARTIFICIAL	string	1	Whether the waterbody is artificial	{Y,N}		
126	16	AltitudeTypology	ALT_CAT	string	4	Altitude category according to Annex II	{HIGH, MID, LOW}		
127	16	GeologyTypology	GEOL_CAT	string	1	Geological category according to Annex II	{C = Calcareous, S = Siliceous, O = Organic)		
128	16	SizeTypology	SIZE_CAT	string	2	Size based on catchment area according to Annex II	{S = Small 0.5-1km, M = Medium 1-10km, L = Large 10-100km, XL = >100km}		
129	16	DepthTypology	DEPTH_CAT	string	1	Depth category based on mean depth	{V = Very Shallow <3m, S = Shallow 3-15m, D = Deep >15m}		
130	16	*Altitude*	ALT			Not defined			
131	16	*Latitude*	LAT	number	8,5	Definition not given in WFD. Assume Latitude (in ETRS89) of mathematical centre of waterbody	Can be calculated from supplied geometry		

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
132	16	*Longitude*	LON	number	8,5	Definition not given in WFD. Assume Longitude (in ETRS89) of mathematical centre of waterbody	Can be calculated from supplied geometry		
133	16	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata
134	17	Identificator	ID	number	24	Unique identifier for features in data set			
135	17	Name	NAME	string	100	Locally used name			
136	17	SegmentCode	SEG_CD	string	24	Unique code for the segment			
137	17	LWBCode	LWB_CD	string	24	Unique Code of Lake Water Body to which this segment belongs		EU_CD	LWBody
138	17	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata
139	18	Identificator	ID	number	24	Unique identifier for features in data set			
140	18	Name	NAME	string	100	Locally used name			
141	18	MSCode	MS_CD	string	22	Unique code for a waterbody within MS	As per coding guidelines		
142	18	EuropeanCode	EU_CD	string	24	Unique code for a waterbody at EU level	As per coding guidelines		
143	18	EcoRegionCode	REGION_CD	string	2	Ecoregion to which a waterbody belongs		REGION_CD	Ecoreg
144	18	System	SYSTEM	string	1	Type of characterization of a waterbody	{A, B}		
145	18	InsertedWhen	INS_WHEN	date	14	Moment of insertion in the database	YYYYMMDDhhmmss		

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
146	18	InsertedBy	INS_BY	string	15	Acronym of operator			
147	18	RiverBasinCode	BASIN_CD	string	24	The code of the parent river basin (see coding system)		EU_CD	RivBasin
148	18	StatusYear	STATUS_YR	string	4	Year of reporting of waterbody characterisation			
149	18	HeavilyModified	MODIFIED	string	1	Whether the waterbody is heavily modified	{Y, N}		
150	18	Artificial	ARTIFICIAL	string	1	Whether the waterbody is artificial	{Y,N}		
151	18	SalinityTypology	SALINITY	string	1	Salinity category according to Annex II	{F = Freshwater, O = Oligohaline, M = Mesohaline, P = Polyhaline, E = Euhaline}		
152	18	TidalTypology	TIDAL	string	5	Tidal range category according to Annex II	{MICRO, MESO,MACRO}		
153	18	*Latitude*	LAT	number	8,5	Definition not given in WFD. Assume Latitude (in ETRS89) of mathematical centre of waterbody	Can be calculated from supplied geometry		
154	18	*Longitude*	LON	number	8,5	Definition not given in WFD. Assume Longitude (in ETRS89) of mathematical centre of waterbody	Can be calculated from supplied geometry		
155	18	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata
156	19	Identificator	ID	number	24	Unique identifier for features in data set			

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
157	19	Name	NAME	string	100	Locally used name			
158	19	WaterBodyCode	BDY_CD	string	24	Unique code of parent GW Body		EU_CD	GWbody
159	19	MSCode	MS_CD	string	22	Unique code for a station at MS level	See coding guidelines.		
160	19	EuropeanCode	EU_CD	string	24	Unique code for a station at EU level	See coding guidelines.		
161	19	InsertedWhen	INS_WHEN	date	14	Moment of insertion in the database	YYYYMMDDhhmmss		
162	19	InsertedBy	INS_BY	string	15	Acronym of operator			
163	19	Level	LEVEL	string	1	Station Type	{Y,N}		
164	19	Operational	OPERAT	string	1	Station Type	{Y,N}		
165	19	Surveillance	SURVEIL	string	1	Station Type	{Y,N}		
166	19	Depth	DEPTH	number	4	Depth in metres			
167	19	MetadataID	META_ID	number	24	Link to Metadata		META_ID	Metadata
168	20	Identificator	ID	number	24	Unique identifier for features in data set			
169	20	Name	NAME	string	100	Locally used name			
170	20	WaterBodyCode	BDY_CD	string	24	Unique code of parent waterbody		EU_CD	RWbody, GWbody, TWbody
171	20	MSCode	MS_CD	string	22	Unique code for a station at MS level	See coding guidelines.		
172	20	EuropeanCode	EU_CD	string	24	Unique code for a station at EU level	See coding guidelines.		

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
173	20	InsertedWhen	INS_WHEN	date	14	Moment of insertion in the database	YYYYMMDDhhmmss		
174	20	InsertedBy	INS_BY	string	15	Acronym of operator			
175	20	Depth	DEPTH	number	4	Depth in metres			
176	20	Drinking	DRINKING	string	1	Station Type	{Y,N}		
177	20	Investigative	INVEST	string	1	Station Type	{Y,N}		
178	20	Operational	OPERAT	string	1	Station Type	{Y,N}		
179	20	Habitat	HABITAT	string	1	Station Type	{Y,N}		
180	20	Surveillance	SURVEIL	string	1	Station Type	{Y,N}		
181	20	Reference	REFERENCE	string	1	Station Type	{Y,N}		
182	20	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata
183	21	Identificator	ID	number	24	Unique identifier for features in data set			
184	21	Name	NAME	string	40	Locally used name			
185	21	EcoRegionCode	REGION_CD	string	2	Codes as specified by Annex XI	{1-25}{AT = Atlantic, NO = Norwegian, BR = Barents, NT = North Sea, BA = Baltic, ME = Mediterranean}		
186	21	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata
187	22	Identificator	ID	number	24	Unique identifier for features in data set			
188	22	Name	NAME	string	100	Locally used name			

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
189	22	ProtectedAreaType	PROT_TYPE	string	1	Category of the protected area	{D = Drinking, R = Recreational, E = Economic Species, N = Nutrient, H = Habitat, B = Bird}		
190	22	MetadataID	META_ID	string	24	Link to Metadata		META_ID	Metadata
191	6	Identificator	ID	number	24	Unique identifier for features in data set			
192	6	MetadataID	META_ID	string	24	Link to Metadata			
193	6	Settlement	SETTLEMENT	string	1	Area is settlement area	{Y,N}		
194	23	Identificator	ID	number	24	Unique identifier for features in data set			
195	23	Name	NAME	string	100	Locally used name			
196	23	WetlandCode	WET_CD	string	24	Wetland Code			
197	23	AreaKM2	AREAKM2	number	6,2	Area in squkm			
198	23	MetadataID	META_ID	string	24	Link to Metadata			
199	24	Identificator	ID	number	24	Unique identifier for features in data set			
200	24	Name	NAME	string	100	Locally used name			
201	24	AcRiskSpotCode	ARS_CD	string	24	Unique code for a Industrial site that forms a risk spot at MS level			
202	24	AcRiskSpotClass	ARS_CL	number	2	Water risk index			
203	24	MetadataID	META_ID	string	24	Link to Metadata			
204	25	Identificator	ID	number	24	Unique identifier for features in data set			

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
205	25	Name	NAME	string	100	Locally used name			
206	25	ContaminatedSiteCode	CS_CD	string	24	Unique code for a contaminated site that forms a risk spot at MS level			
207	25	ContaminatedSiteClass	CS_CL	number	2	M1 Methodology			
208	26	Identificator	ID	number	24	Unique identifier for features in data set			
209	26	MetadataID	META_ID	string	24	Link to Metadata			
210	26	Name	NAME	string	100	Locally used name			
211	26	PointSource	PS_CD	string	24	Unique code for point source of pollution - Link to Parameter Tables in EMIS			
212	26	PointSourceClass	PS_CL	number	2	Kind of Point Source	{A = Agricultural, I = Industrial, M = Municipal, N = Nuclear, O = Other}		
213	26	SegmentCode	SEG_CD	string	24	Unique code for the river segment which is recipient of the discharger (for lakes the imaginary river through the lake is the recipient)		SEG_CD	RWseg
214	26	MetadataID	META_ID	string	24	Link to Metadata			
215	27	Identificator	ID	number	24	Unique identifier for features in data set			
216	27	Name	NAME	string	100	Locally used name			
217	27	HarbourCode	HARBOUR_CD	string	24	Unique code for harbours			

field_id	table_id	attribute_name	field_name	field_type	length	attribute_desc	possible_values	key_to_field	linked_table
218	27	SegmentCode	SEG_CD	string	24	Unique code for the river segment where the harbour is located			
219	27	MetadataID	META_ID	string	24	Link to Metadata			
220	28	Identificator	ID	number	24	Unique identifier for features in data set			
221	28	Name	NAME	string	100	Locally used name			
222	28	HydrologicalStructure Code	HS_CD	string	24	Unique code for the hydrological structure			
223	28	SegmentCode	SEG_CD	string	24	Unique code for the river segment where the hydrological structure is located or where it forms its endpoint			
224	28	HydrologicalStructure Class	HS_CL	string	2	Classification of Hydrological Structure	{D = Dam, W = Weir, ...}		
225	28	MetadataID	META_ID	string	24	Link to Metadata			
226	29	Identificator	ID	number	24	Unique identifier for features in data set			
227	29	Geology Code	GEOL_CD	string	24	Unique code for geologic types			
228	29	MetadataID	META_ID	string	24	Link to Metadata			

ANNEX B: METADATA

ANNEX B: METADATA

Table 1: Metadata

The following Metadata list is based on ISO 19115. To make it easily comparable with the ISO standard, the classes as well as the identification numbers from the ISO 19115 data dictionary are listed.

Description of Metadata list fieldnames:

Metadata groups	for DRB GIS metadata has been grouped into topics
Metadata Element	metadata element as in ISO 19115
ISO 19115 ID	identification number for object classes entities or class attribute elements as used in ISO 19115 data dictionary
Type	data type
Cardinality	number of instances the entity or elements may have
Domain	value domain
Obligation	M = mandatory, C = mandatory under certain circumstances (which mostly apply to the Danube GIS – thus these C - fields can be seen as mandatory too), O = Optional (some optional elements will be automatically created by the system
Short name	short name for the entity/element provided by ISO 19115
Short description	description for the entity/element
Data input	is data input necessary – N = no data input (all rows showing classes have no data input), Y = data input necessary
Examples	one example for the metadata
Comments	comments

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
Common Metadata	Metadata file identifier	2	MD_Metadata.fileIdentifier	Character String	1	free text	O	mdFileID	Unique identifier for the metadata file	N		
	Metadata language	3	MD_Metadata.language	Character String	1	ISO 639-2 <<CodeList>>	C	mdLang	Metadata language	Y	002	002 = german
	Metadata character set	4	MD_Metadata.characterSet >> MD_CharacterSetCode	Class	1	<<CodeList>> Character Set Code	C	mdChar	Metadata character set	Y	004	004 = utf8 = 8-bit variable size UCS Transfer Format, based on ISO/IEC 10646
	Metadata hierarchy level	6	MD_Metadata.hierarchyLevel >> MD_ScopeCode	Class	N	<<CodeList>> Scope Code	C	mdHrLv	Metadata scope	Y	005	005 = dataset
	Metadata date stamp	9	MD_Metadata.dateStamp	Class	1	Date		mdDateSt	Date of metadata creation	Y	2004-11-16T02:48:21	ISO 8601 YYYY-MM-DDThh:mm:ss
	Metadata standard name	10	MD_Metadata.metadataStandardName	Character String	1	free text	O	mdStanName	Metadata standard name (inkl. profile name)	Y	ISO 19115	
	Metadata standard version	11	MD_Metadata.metadataStandardVersion	Character String	1	free text	O	mdStanVer	Version (profile) of metadatenstandard	Y	ISO 19115, First edition, 2003-05-01	
	Metadata point of contact	8	MD_Metadata.contact >>	Class	N	CI_ResponsibleParty	M	mdContact	responsibe person/organisation	N		

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
	Responsible Party	375	CI_ResponsibleParty.individualName	Character String	1	free text	M	rpIndName	Name of responsible person: surname, first name, title	Y	Roder, Ingrid MMag.	
		376	CI_ResponsibleParty.organisationName	Character String	1	free text	M	rpOrgName	Name of responsible organisation	Y	Umweltbundesamt Wien, Abt. GIS	
		378	CI_ResponsibleParty.contactInfo >>	Class	1	CI_Contact	O	rpCntInfo	Adress of responsible organisation	N		
		388	CI_Contact.phone >>	Class	1	CI_Telephone	O	cntPhone	Telephone number where the person or organisation can be contacted	N		
		408	CI_Telephone.voice	Character String	N	free text	O	voiceNum	Telephone number	Y	0043-(0)1-31304-5900	
		409	CI_Telephone.facsimile	Character String	N	free text	O	faxNum	Faxnumber	Y	0043-(0)1-31304-3571	
Contact		380	CI_Contact.address >>	Class								

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
		381	CI_Adress.deliveryPoint	Character String	1	free text	O	delPoint	Adress (street)	Y	Treustraße 35	Follows 11180, Annex A
		382	CI_Adress.city	Character String	1	free text	O	city	City	Y	Wien	
		384	CI_Adress.postalCode	Character String	1	free text	O	postCode	Postcode	Y	1200	
		385	CI_Adress.country	Character String	1	ISO 3166-3	O	country	Country	Y	AT	Follows ISO 3166
		386	CI_Adress.electronicMail Address	Character String	N	free text	O	eMailAdd	Email where the person or organisation can be contacted	Y	ingrid.roder@umweltbundesamt.at	
		379	CI_ResponsibleParty.role	Class	1	<<CodeList>> CI_RoleCode	M	role	Function of responsible person in the organisation	Y	007	007 = party who can be contacted for acquiring knowledge about or acquisition of the resource

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
		390	CI_Contact.OnlineResource >>	Class	1	CI_OnlineResource	O	cntOnlineRes	Online Information that can be used to contact responsible person or organisation	N		
		397	CI_OnlineResource.linkage >>	URL	1	URL	M	linkage	URL (Uniform Resource Locator)	Y	http://www.umweltbundesamt.at	see IETF RFC1738, IETF RFC 2056
		391	CI_Contact.hoursOfService	Character String	1	free text	O	cntHours	Contact hours	Y	Mo - Th 09:00 - 12:00 MEZ	
		392	CI_Contact.contactInstructions	Character String	1	free text	O	cntInstr	Additional information for contact	Y	Monday: focus vecor data; Thursday: focus raster data	
Data Identification	Citation	24	MD_Identification.citation >>	Class	1	CI_Citation	M	idCitation	Citation for data resource	N		
	Dataset title	360	CI_Citation.title	Character String	1	free text	M	resTitle	Name for the cited data resource	Y	Austrian lake data set 1 : 50.000	
		361	CI_Citation.alternateTitle	Character String	1	free text	O	resAltTitle	Short name or foreign language name for cited resource	Y	AT lakes 50	

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
	Dataset reference date	362	CI_Citation.date >>	Class	N	CI_Date	M	resRefDate	Refencedate for cited resource	N		
		394	CI_Date.date	Class	1	Date	M	refDate	Referencedate	Y	2004-11-16T02:48:21	ISO 8601 YYYY-MM-DDThh:mm:ss
		395	CI_Date.dateType	Class	1	<<CodeList>> CI_DateTypeCode	M	refDateType	Event used for reference date	Y	001	001 = creation
	Dataset edition	363	CI_Citation.edition	Character String	1	free text	O	resEd	Version of cited resource	Y	Version 03	
		364	CI_Citation.editionDate	Class	1	Date	M	resEdDate	Version date	Y	2004-11-16T03:18:44	
	Keywords	52	MD_Keywords.keyword	Character String	N	free text	M	keyword	Keywords or Phrases that describe the data set	Y	Lakes	AThesaurus should be created
	Dataset topic category	41	MD_DataIdentification.topicCategory	Class	N	<<Enumeration>>MD_TopicCategoryCode	C	tpCat	Main theme of the data set	Y	012	012 = Inland Waters

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
	Abstract describing the dataset	25	MD_DataIdentification.abstract	Character String	1	free text	M	idAbs	Brief narrative summary of the contents of the resource	Y	The dataset was created in the lake project 2002 and contains lakes greate than 10000 sqm	
		206	MD_Identifier.authority	Class	1	CI_Responsible Party	O	identAuth	Person or party responsible for maintenance of the namespace	N		
		207	MD_Identifier.code	Character String	1	free text	M	identCode	Alphanumeric value identifying an instance in the namespace	Y		
	Cited Responsible Party	367	CI_Citation.citedResponsibleParty	Class	N	CI_Responsible Party	O	citRespParty	Person or party responsible for the cited resource	N		
	Dataset language	39	MD_DataIdentification.language	Character String	N	ISO 639-2 <<CodeList>>	M	dataLang	Language that was used for the resource	Y	002	002 = german
	Dataset character set	40	MD_DataIdentification.characterSet	Class	N	<<CodeList>> MD_CharacterSetCode	C	dataChar	Name of character coding standard	Y	004	004 = utf8 = 8-bit variable size UCS Transfer Format, based on ISO/IEC 10646

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
	Status	28	MD_DataIdentification.status	Class	N	<<CodeList>> MD_ProgressCode	O	idStatus	Resource status	Y	001	001 = completed
	Spatial Representation	37	MD_DataIdentification.spatialRepresentationType	Class	N	<<CodeList>> MD_SpatialRepresentation Type Code	O	spatRpType	Method of spatial representation	Y	001	001 = vector
	Spatial Resolution	38	MD_DataIdentification.spatialResolution	Class	N	<<Union>> MD_Resolution	M	dataScale	Factor which provides a general understanding of the density of spatial data in the dataset	N		
		61	MD_Resolution.distance	Class	1	Distance	M	scaleDist	Ground sample distance	Y	20	
	Geographic location of the dataset (4 coordinates or geographic identifier)	344	EX_GeographicBoundingBox.westBoundLongitude	Class	1	-180 <= Longitude >= 180	M	westBL	Western-most coordinate of the limit of the dataset extent in decimal degrees	Y	9	9°

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
		345	EX_GeographicBoundingBox.eastBoundLongitude	Class	1	-180 <= Longitude >= 180	M	eastBL	Eastern-most coordinate of the limit of the dataset extent in decimal degrees	Y	18	18°
		346	EX_GeographicBoundingBox.southBoundLatitude	Class	1	-90 <= Latitude >= 90	M	southBL	Southern-most coordinate of the limit of the dataset extent in decimal degrees	Y	45	45°
		347	EX_GeographicBoundingBox.northBoundLatitude	Class	1	-90 <= Latitude >= 90	M	northBL	Northern-most coordinate of the limit of the dataset extent in decimal degrees	Y	47	47°
Data Constraints	Use Limitation	68	MD_Constraints.useLimitation	Character String	N	Free text	O	useLimit	Limitation affecting the fitness for use of the resource or metadata.	Y	For data presentation in scales between 1 : 25.000 and 1 : 250.000	

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
	Constraints	70	MD_LegalConstraints.accessConstraints	Class	N	<<CodeList>> MD_Restriction Code	O	accessConsts	Access constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations on obtaining the resource or metadata.	Y	005	005 = license
		71	MD_LegalConstraints.useConstraints	Class	N	<<CodeList>> MD_Restriction Code	O	useConsts	Constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations or warnings on using the resource or metadata	Y	005	005 = license
		72	MD_LegalConstraints.otherConstraints	Character String	N	Free text	C	othConsts	Other restrictions and legal prerequisites for accessing and using the resource or metadata	Y		

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
		74	MD_SecurityConstraints.classification	Class	1	<<CodeList>> MD_ClassificationCode	M	class	Name of Restriction for Data or Metadata use	Y	003	003 = confidential, i.e. for internal use only
		75	MD_SecurityConstraints.userNote	Character String	1	Free text	O	userNote	Explanation of the application of the legal constraints or other restrictions and legal prerequisites for obtaining and using the resource or metadata	Y	copyright Umweltdaten GmbH	
Reference System	Reference System	196	RS_ReferenceSystem.name	Class	1	RS_Identifier	M	refSysName	Reference system name	N		
		208	RS_Identifier.codeSpace	Character String	1	Free text	O	identCodeSpace	Name or identifier of person or organisation who creates the projection name	Y	ESRI	
		207	MD_Identifier.code	Character String	1	Free text	M	identCode	Alphanumeric value identifying an instance in the namespace	Y	MGI_Lambert_Austria	

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
		202	MD_EllipsoidParameters.semiMajorAxis	Real	1	>0.0	M	semiMajAx	Radius of the equatorial axis of the ellipsoid	Y	6377397,155000000300000000	
		203	MD_EllipsoidParameters.axisUnits	Class	1	UomLength (documented in ISO 19103)	M	axisUnits	Units of the semi-major axis	Y	meters	
		204	MD_EllipsoidParameters.denominatorOfFlatteningRatio	Real	1	>0.0	M	denFlatRat	Ratio of the difference between the equatorial and polar radii of the ellipsoid to the equatorial radius	Y	299,152812799999990000	
	Projection	216	MD_ProjectionParameters.zone	Integer	1	Integer	O	zone	Zone number (e.g. in UTM)	Y		
		217	MD_ProjectionParameters.standardParallel	Real	2	Real	O	stanParal	Standard parallels	Y	46	
		218	MD_ProjectionParameters.longitudeOfCentralMeridian	Real	1	Real	O	lonCntMer	Central meridian	Y	13,3333333333333333	
		219	MD_ProjectionParameters.latitudeOfProjectionOrigin	Real	1	Real	O	latProjOri	Central latitude	Y	47,5	

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
		220	MD_ProjectionParameters.falseEasting	Real	1	Real	O	falEasting	False Easting	Y	400000	
		221	MD_ProjectionParameters.falseNorthing	Real	1	Real	O	falNorthing	False Northing	Y	400000	
		222	MD_ProjectionParameters.falseEastingNorthingUnits	Class	1	UomLength 19103	O	falENUnits	Units of False Easting and False Northing	Y	meters	
		223	MD_ProjectionParameters.scaleFactorAtEquator	Real	1	>0.0	O	sclFacEqu	Ratio between physical distance and corresponding map distance, along the equator	Y	1	
		227	MD_ProjectionParameters.scaleFactorAtCenterLine	Real	1	Real	O	sclFacCnt	Ratio between physical distance and corresponding map distance along the centre line	Y		

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
		229	MD_ProjectionParameters.scaleFactorAtProjectionOrigin	Real	1	Real	O	sclFacPrOr	Multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance at the projection origin	Y		
Data Quality		79	DQ_DataQuality.scope	Class	1	DQ_Scope	M	DataQual	Data quality information	N		is instantiated DQ_Scope
		138	DQ_Scope.level	Class	1	<<CodeList>> MD_ScopeCode	M	scpLvl	Detailed description about the level of the data specified by the scope	Y	005	005 = dataset

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
		83	LI_lineage.statement	Character String	1	Free text	M	statement	General explanation of the data producer's knowledge about the lineage of a dataset	Y	The data has been extracted from the Austrian Digital landscape model 1 : 50.000 and was complemented with information that was gathered via a questionnaire from the app. 2000 Austrian administrative communities.	
Data Details	Topology	177	MD_VectorSpatialRepresentation.topologylevel	Class	1	<<CodeList>> MD_TopologyLevelCode	C	topLvl	Code which identifies the degree of complexity of the spatial relationships	Y	004	004 = full planar graph (topolgy that usually applies to the 2D vector space of gis-data)

Metadata topics	Metadata Element (ISO 19115)	ISO 19115 ID	Classes/Attributes ISO 19115	Type	Cardinality	Domain	Obligation	Short name	Short description	Data input	Examples	Comments
	Geometric Objects	184	MD_GeometricObjects	Class	1	<<CodeList>> MD_GeometricObjectTypeCode	M	geoObjTyp	Name of point or vector objects used to locate zero-, one-, two-, or three-dimensional spatial locations in the dataset	Y		

Table 2: Metadata Codelists

ISO 639-2 Language Code

ID	Name	Domain-Code	Definition
1	dan	001	Danish
2	ger	002	German
3	eng	003	English
4	est	004	Estonian
5	fin	005	Finnish
6	fre	006	French
7	gre	007	Greek
8	ita	008	Italian
9	lav	009	Latvian
10	lit	010	Lithuanian
11	mlt	011	Maltese
12	dut	012	Dutch, Flemish
13	pol	013	Polish
14	por	014	Portuguese
15	swe	015	Swedish
16	slo	016	Slovak
17	slv	017	Slovenian
18	spa	018	Spanish
19	cze	019	Czech
20	hun	020	Hungarian
21	alb	021	Albanian
22	bos	022	Bosnian
23	bul	023	Bulgarian
24	scr	024	Croatian
25	mac	025	Macedonian
26	mol	026	Moldovian
27	rum	027	Romanian
28	scc	028	Serbian
29	ukr	029	Ukrainian

B.5.2 Date type Code

ID	Name	Domain-Code	Definition
1	CI_DateTypeCode	DateTypCd	identification of when a given event occurred
2	creation	001	date identifies when the resource was brought into existence
3	publication	002	date identifies when the resource was issued
4	revision	003	date identifies when the resource was examined or re-examined and improved or amended

B.5.5 Role Code

ID	Name	Domain-Code	Definition
1	CI_RoleCode	RoleCd	function performed by the responsible party
2	resourceProvider	001	party that supplies the resource
3	custodian	002	party that accepts accountability and responsibility for the data and ensures appropriate care and maintenance of the resource
4	owner	003	party that owns the resource
5	user	004	party who uses the resource
6	distributor	005	party who distributes the resource
7	originator	006	party who created the resource
8	pointOfContact	007	party who can be contacted for acquiring knowledge about or acquisition of the resource
9	principalInvestigator	008	key party responsible for gathering information and conducting research
10	processor	009	party who has processed the data in a manner such that the resource has been modified
11	publisher	010	party who published the resource

B.5.10 Character Set Code

ID	Name	Domain-Code	Definition
1	MD_CharacterSetCode	CharSetCd	name of the character coding standard used for the resource
2	ucs2	001	16-bit fixed size Universal Character Set, based on ISO/IEC 10646
3	ucs4	002	32-bit fixed size Universal Character Set, based on ISO/IEC 10646
4	utf7	003	7-bit variable size UCS Transfer Format, based on ISO/IEC 10646
5	utf8	004	8-bit variable size UCS Transfer Format, based on ISO/IEC 10646

6	utf16	005	16-bit variable size UCS Transfer Format, based on ISO/IEC 10646
7	8859part1	006	ISO/IEC 8859-1, Information technology – 8-bit single-byte coded graphic character sets – Part 1 Latin alphabet No. 1
8	8859part2	007	ISO/IEC 8859-2, Information technology – 8-bit single-byte coded graphic character sets – Part 2 Latin alphabet No. 2
9	8859part3	008	ISO/IEC 8859-3, Information technology – 8-bit single-byte coded graphic character sets – Part 3 Latin alphabet No. 3
10	8859part4	009	ISO/IEC 8859-4, Information technology – 8-bit single-byte coded graphic character sets – Part 4 Latin alphabet No. 4
11	8859part5	010	ISO/IEC 8859-51, Information technology – 8-bit single-byte coded graphic character sets – Part 5 Latin/Cyrillic alphabet
12	8859part6	011	ISO/IEC 8859-6, Information technology – 8-bit single-byte coded graphic character sets – Part 6 Latin/Arabic alphabet
13	8859part7	012	ISO/IEC 8859-7, Information technology – 8-bit single-byte coded graphic character sets – Part 7 Latin/Greek alphabet
14	8859part8	013	ISO/IEC 8859-8, Information technology – 8-bit single-byte coded graphic character sets – Part 8 Latin/Hebrew alphabet
15	8859part9	014	ISO/IEC8859-9, Information technology – 8-bit single-byte coded graphiccharacter sets – Part 9 Latin alphabet No. 5
16	8859part11	015	thai code set
17	8859part14	016	latin-8 code set
18	8859part15	017	latin-9 code set
19	jis	018	japanese code set used for electronic transmission
20	shiftJIS	019	japanese code set used on MS-DOS based machines
21	eucJP	020	japanese code set used on UNIX based machines
22	usAscii	021	united states ASCII code set (ISO 646 US)
23	ebcdic	022	ibm mainframe code set
24	eucKR	023	korean code set
25	big5	024	taiwanese code set
26	8859part10	025	latin-6 code set
27	8859part13	026	latin-7 code set

B.5.11 Classification Code

ID	Name	Domain-Code	Definition
1	MD_ClassificationCode		
2	unclassified	001	available for general disclosure
3	restricted	002	not for general disclosure
4	confidential	003	available for someone who can be entrusted with information
5	secret	004	kept or meant to be kept private, unknown or hidden from all but a selected group of people

B.5.15 MD_GeometricObjectTypeCode

ID	Name	Domain-Code	Definition
1	MD_GeometricObjectType Code	GeoObjTypCd	name of point or vector objects used to locate zero-, one-, two-, or three-dimensional spatial locations in the dataset
2	complex	001	set of geometric primitives such that their boundaries can be represented as a union of other primitives
3	composite	002	connected set of curves, solids or surfaces
4	curve	003	bounded, 1-dimensional geometric primitive, representing the continuous image of a line
5	point	004	zero-dimensional geometric primitive, representing a position but not having an extent
6	solid	005	bounded, connected 3-dimensional geometric primitive, representing the continuous image of a region of space
7	surface	006	bounded, connected 2-dimensional geometric primitive, representing the continuous image of a region of a plane

B.5.23 Progress Code

ID	Name	Domain-Code	Definition
1	MD_ProgressCode	ProgCd	status of the dataset or progress of a review
2	completed	001	production of the data has been completed
3	historicalArchive	002	data has been stored in an offline storage facility
4	obsolete	003	data is no longer relevant
5	onGoing	004	data is continually being updated
6	planned	005	fixed date has been established upon or by which the data will be created or updated

7	required	006	data needs to be generated or updated
8	underDevelopment	007	data is currently in the process of being created

B.5.24 Restriction Code

ID	Name	Domain-Code	Definition
1	MD_RestrictionCode	RestrictCd	limitation(s) placed upon the access or use of the data
2	copyright	001	exclusive right to the publication, production, or sale of the rights to a literary, dramatic, musical, or artistic work, or to the use of a commercial print or label, granted by law for a specified period of time to an author, composer, artist, distributor
3	patent	002	government has granted exclusive right to make, sell, use or license an invention or discovery
4	patentPending	003	produced or sold information awaiting a patent
5	trademark	004	a name, symbol, or other device identifying a product, officially registered and legally restricted to the use of the owner or manufacturer
6	license	005	formal permission to do something
7	intellectualProperty Rights	006	rights to financial benefit from and control of distribution of non-tangible property that is a result of creativity
8	restricted	007	withheld from general circulation or disclosure
9	otherRestrictions	008	limitation not listed

B.5.25 Scope Code

ID	Name	Domain-Code	Definition
1	MD_ScopeCode	ScopeCd	class of information to which the referencing entity applies
2	attribute	001	information applies to the attribute class
3	attributeType	002	information applies to the characteristic of a feature
4	collectionHardware	003	information applies to the collection hardware class
5	collectionSession	004	information applies to the collection session
6	dataset	005	information applies to the dataset
7	series	006	information applies to the series
8	nonGeographicData set	007	information applies to non-geographic data
9	dimensionGroup	008	information applies to a dimension group
10	feature	009	information applies to a feature

11	featureType	010	information applies to a feature type
12	propertyType	011	information applies to a property type
13	fieldSession	012	information applies to a field session
14	software	013	information applies to a computer program or routine
15	service	014	information applies to a capability which a service provider entity makes available to a service user entity through a set of interfaces that define a behaviour, such as a use case
16	model	015	information applies to a copy or imitation of an existing or hypothetical object
17	nationalContribution	016	information applies to the national contribution to the dataset

B.5.26 Spatial Representation Type Code

ID	Name	Domain-Code	Definition
1	MD_SpatialRepresentationTypeCode	SpatRepTypCd	method used to represent geographic information in the dataset
2	vector	001	vector data is used to represent geographic data
3	grid	002	grid data is used to represent geographic data
4	textTable	003	textual or tabular data is used to represent geographic data
5	tin	004	triangulated irregular network
6	stereoModel	005	three-dimensional view formed by the intersecting homologous rays of an overlapping pair of images
7	video	006	scene from a video recording

B.5.27 Topic Category Code

ID	Name	Domain-Code	Definition
1	MD_TopicCategoryCode	TopicCatCd	high-level geographic data thematic classification to assist in the grouping and search of available geographic data sets. Can be used to group keywords as well. Listed examples are not exhaustive. NOTE: It is understood there are overlaps between general categories and the user is encouraged to select the one most appropriate.
2	farming	001	rearing of animals and/or cultivation of plants Examples: agriculture, irrigation, aquaculture, plantations, herding, pests and diseases affecting crops and livestock
3	biota	002	flora and/or fauna in natural environment Examples: wildlife, vegetation, biological sciences, ecology, wilderness, sealife, wetlands, habitat

4	boundaries	003	legal land descriptions Examples: political and administrative boundaries
5	climatologyMeteorologyAtmosphere	004	processes and phenomena of the atmosphere Examples: cloud cover, weather, climate, atmospheric conditions, climate change, precipitation
6	economy	005	economic activities, conditions and employment Examples: production, labour, revenue, commerce, industry, tourism and ecotourism, forestry, fisheries, commercial or subsistence hunting, exploration and exploitation of resources such as minerals, oil and gas
7	elevation	006	height above or below sea level Examples: altitude, bathymetry, digital elevation models, slope, derived products
8	environment	007	environmental resources, protection and conservation Examples: environmental pollution, waste storage and treatment, environmental,impact assessment, monitoring environmental risk, nature reserves, landscape
9	geoscientificInformation	008	information pertaining to earth sciences Examples: geophysical features and processes, geology, minerals, sciences,dealing with the composition, structure and origin of the earth's rocks, risks of earthquakes, volcanic activity, landslides, gravity information, soils, permafrost, hydrogeology, erosion
10	health	009	health, health services, human ecology, and safety Examples: disease and illness, factors affecting health, hygiene, substance abuse, mental and physical health, health services
11	imageryBaseMapsEarthCover	010	base maps Examples: land cover, topographic maps, imagery, unclassified images, annotations
12	intelligenceMilitary	011	military bases, structures, activities Examples: barracks, training grounds, military transportation, information collection
13	inlandWaters	012	inland water features, drainage systems and their characteristics Examples: rivers and glaciers, salt lakes, water utilization plans, dams, currents, floods, water quality, hydrographic charts
14	location	013	positional information and services Examples: addresses, geodetic networks, control points, postal zones and services, place names
15	oceans	014	features and characteristics of salt water bodies (excluding inland waters) Examples: tides, tidal waves, coastal information, reefs

16	planningCadastre	015	information used for appropriate actions for future use of the land Examples: land use maps, zoning maps, cadastral surveys, land ownership
17	society	016	characteristics of society and cultures Examples: settlements, anthropology, archaeology, education, traditional beliefs, manners and customs, demographic data, recreational areas and activities, social impact assessments, crime and justice, census information
18	structure	017	man-made construction Examples: buildings, museums, churches, factories, housing, monuments, shops, towers
19	transportation	018	means and aids for conveying persons and/or goods Examples: roads, airports/airstrips, shipping routes, tunnels, nautical charts, vehicle or vessel location, aeronautical charts, railways
20	utilitiesCommunication	019	energy, water and waste systems and communications infrastructure and services Examples: hydroelectricity, geothermal, solar and nuclear sources of energy, water purification and distribution, sewage collection and disposal, electricity and gas distribution, data communication, telecommunication, radio, communication networks

B.5.28 MD_TopologyLevelCode

ID	Name	Domain-Code	Definition
1	MD_TopologyLevelCode	TopoLevCd	degree of complexity of the spatial relationships
2	geometryOnly	001	geometry objects without any additional structure which describes topology
3	topology1D	002	1-dimensional topological complex – commonly called “chain-node” topology
4	planarGraph	003	1-dimensional topological complex that is planar. (A planar graph is a graph that can be drawn in a plane in such a way that no two edges intersect except at a vertex.)
5	fullPlanarGraph	004	2-dimensional topological complex that is planar. (A 2-dimensional topological complex is commonly called “full topology” in a cartographic 2D environment.)
6	surfaceGraph	005	1-dimensional topological complex that is isomorphic to a subset of a surface. (A geometric complex is isomorphic to a topological complex if their elements are in a one-to-one, dimensional-and boundry-preserving correspondence to one

			another.)
7	fullSurfaceGraph	006	2-dimensional topological complex that is isomorphic to a subset of a surface
8	topology3D	007	3-dimensional topological complex. (A topological complex is a collection of topological primitives that are closed under the boundary operations.)
9	fullTopology3D	008	complete coverage of a 3D Euclidean coordinate space
10	abstract	009	topological complex without any specified geometric realisation

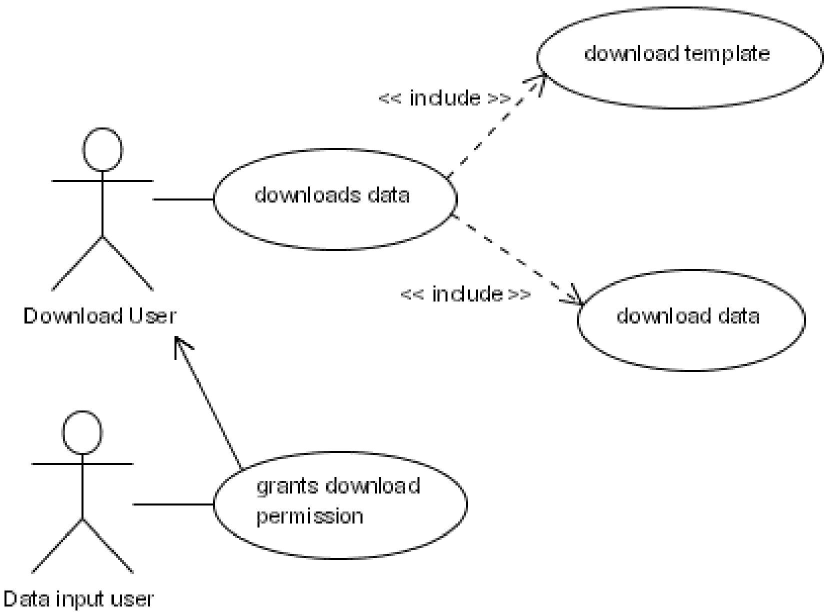
ANNEX C: USE CASES

ANNEX C: USE CASES

The following form sheets **do not include all possible use cases** but provide an overview of the main tasks of Danube River Basin GIS.

USE CASE: DATA DOWNLOAD TOOL (UC_1)

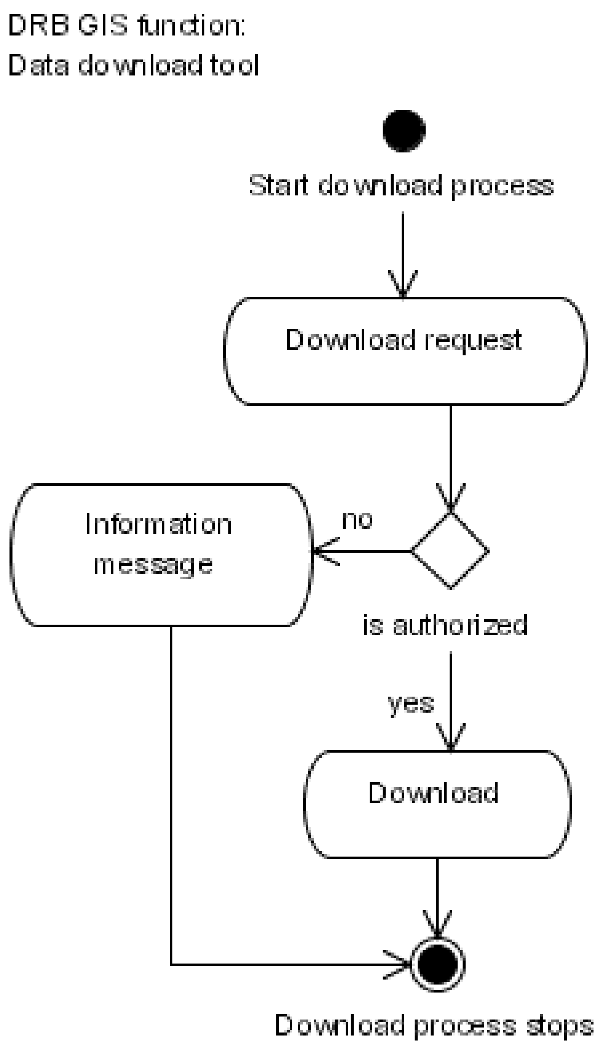
ID: UC_1	**Use Case Data Download Tool**



Short description	The authorized download user retrieves the datasets which where granted to him by the owner (data input user).
Sub Use Case from	---
Has Sub Use Case(s)	---
Actor(s)	data input user, download user
Triggered by	Download user
Output	The datasets, databundles or categories are downloaded. if authorization fails: Information message from whom the download user may obtain the permission to download data.
Precondition(s)	When the user is logging in, the system checks his authentification (user name and password) and authorization (access to data and tools). The data input user has granted the download user download rights for the respective datasets.
After fulfillment	The download user has the datasets on local harddisk or netwrk for further processing.
Comment(s)	Depending on his permission, the download user may not only download data but also templates. These templates represent geodatasets and tables necessary for the DRB GIS database.

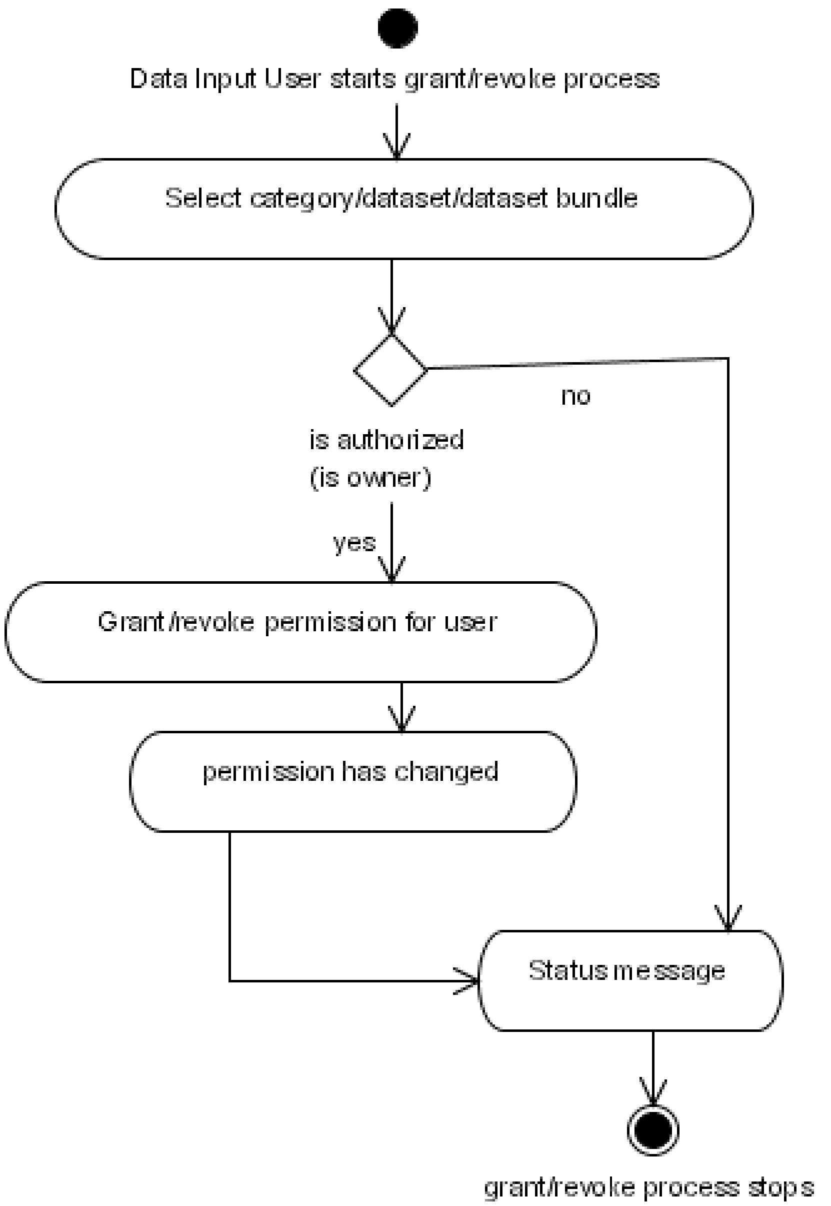
ACTIVITY DIAGRAM: USAGE OF DOWNLOAD TOOL (AC_11)

ID: AC_11	**Activity Diagram to Use Case Data Download (UC_1)** **Usage of download tool**



Comment(s)	The information message informs the download user that he does not have sufficient user rights to download the data required. It states who is responsible for these datasets so that he/she can contact the data input user who may grant the relevant rights.

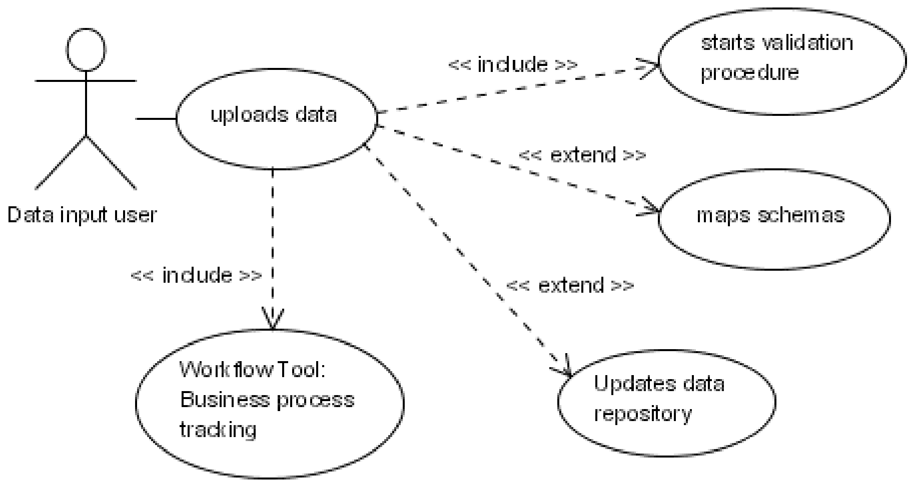
ACTIVITY DIAGRAM: GRANTING OF PRIVILEGES (AC_12)

<table>
<tr><td>ID: AC_12</td><td>Activity Diagram to Use Case Data Download (UC_1)
Granting of privileges</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td>Comment(s)</td><td>The data input user is allowed to grant privileges to the download user but only for the datasets he owns. If a category is selected, all included datasets and data bundles are granted.

If there are legal restrictions that prohibit the transmission of the required data, the data input user has to obtain permission from the decision maker.</td></tr>
</table>

USE CASE: DATA UPLOAD (UC_2)

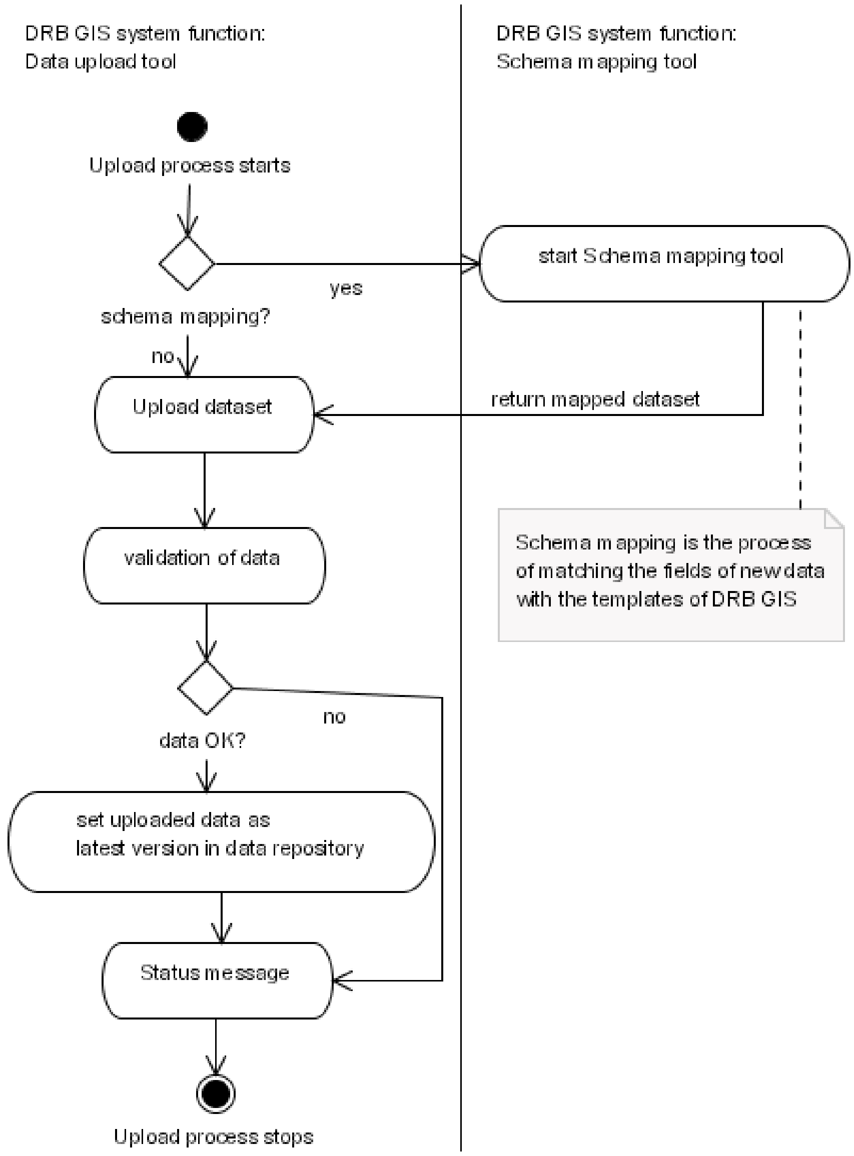
ID: UC_2	**Upload of data to DRB GIS**



Short description	Data input users are GIS experts who want to upload data via the DRB GIS web portal. To guarantee appropriate data: the data have to be validated the workflow tool tracks the business process optional: The original schema of datasets and the schema of the DRB GIS database have to be matched optional: If data is already available, the update version is marked as current release, the old version is archived.
Sub Use Case from	---
Has Sub Use Case(s)	UC_21, UC_22
Actor(s)	Data input user
Triggered by	Data requirements for the DRB GIS
Output	New datasets are added to DRB GIS Database Feedback is shown as status message on the webpage
Precondition(s)	Geo datasets are in ESRI Shapefile data format. Tables are in tab delimited data format
After fulfillment	New release is available in DRB GIS Database
Comment(s)	

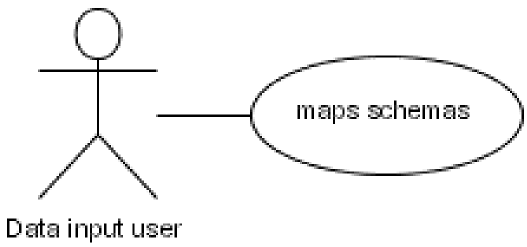
Activity diagram: Usage of upload tool (AC_21)

ID: AC_21	Activity Diagram to Use Case Data Upload (UC_2) Usage of upload tool



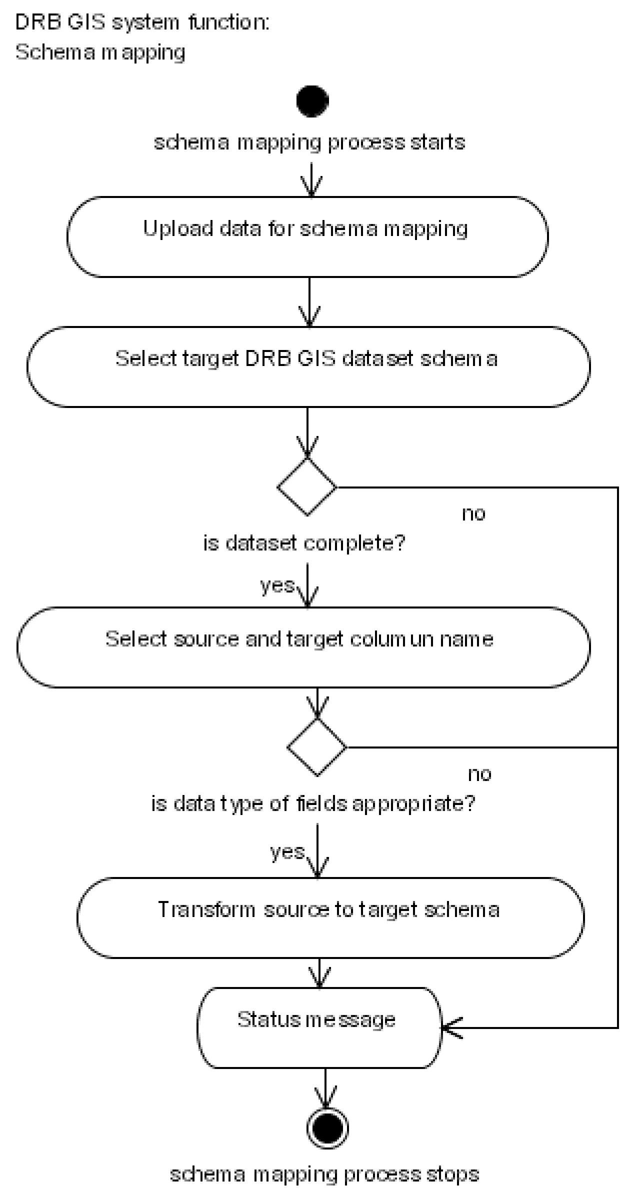
Comment(s)	Schema mapping is optional. If the data is available in a format conforming to the templates provided, schema mapping is not necessary. The validation process may differ depending on which dataset is uploaded. If there already is a current release available in the DRB GIS data repository, the uploaded release replaces the old one. The old dataset is not deleted, but is still available in the data repository.

Sub Use Case: Schema mapping (UC_21)

ID: UC_21	**Schema mapping**
	
Short description	Schema mapping means to transform a dataset from a source into a target format. The user generates - supported by web based tools - a mapping directive between source and target column names. The result are mapping directives, which column name in the source file is corresponding to which column name in the target schema. Before national datasets with a national naming convention can be stored in the data repository they need to be mapped to DRB GIS schema. If the datasets are not appropriate (e.g. incomplete datasets, data types not matching) schema mapping is rejected.
Sub Use Case from	UC_2
Has Sub Use Case(s)	---
Actor(s)	Data input user
Triggered by	Data requirements for the DRB GIS
Output	Message that mapping is correct or Message that changes are required before schema mapping can be finished
Precondition(s)	Geo datasets are in ESRI Shapefile data format. Tables are in tab delimited data format The data types of the source column must be the same as the target column.
After fulfillment	Update of data repository is starting.
Comment(s)	Templates are available to show how DRB GIS data have to be structured.

Activity Diagram: Schema Mapping (AC_211)

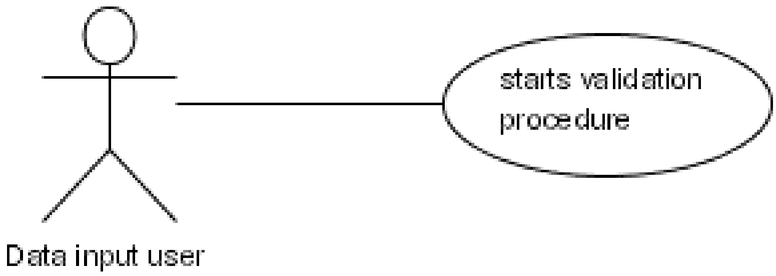
ID: AC_211	**Activity Diagram to Sub Use Case Schema mapping (UC_21): Starts schema mapping process**



Comment(s)	The schema mapping process may differ depending on which dataset is uploaded.

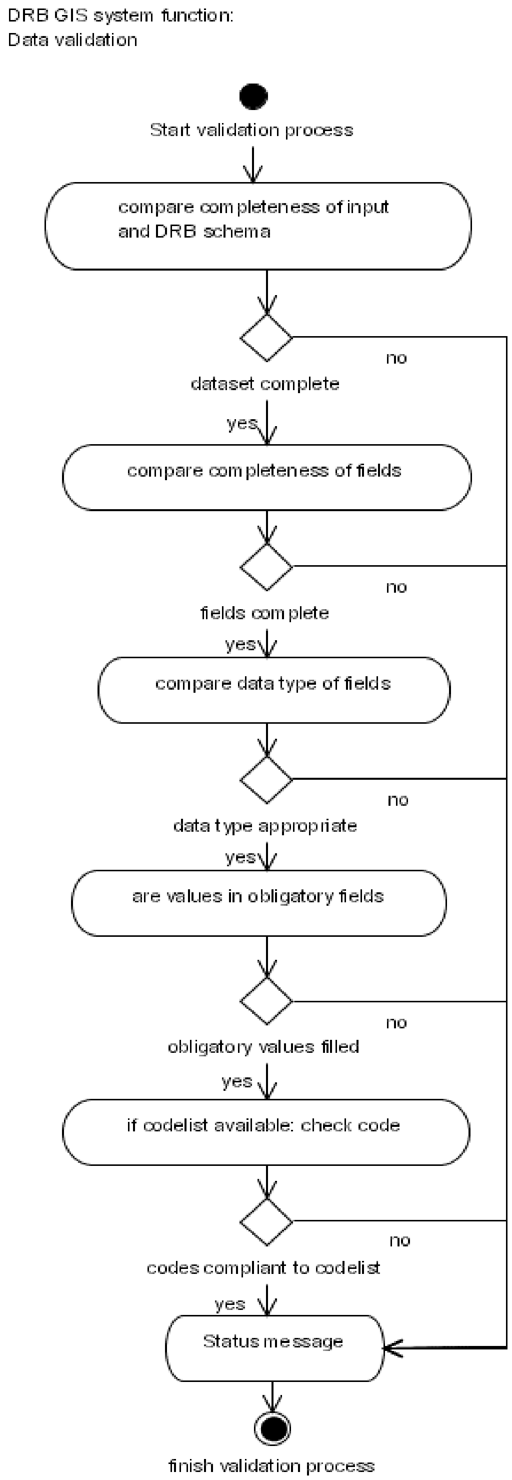
Sub Use Case: Starts Validation Procedure (UC_22)

ID: UC_22	**Starts validation procedure**



Short description	Before datasets are stored in the data repository they have to be validated. If the datasets are not appropriate, the upload is rejected. Schema mapping has to be done in advance.
Sub Use Case from	UC_2
Has Sub Use Case(s)	---
Actor(s)	Data input user
Triggered by	Data requirements for the DRB GIS
Output	Message that data are correct or Message that changes are required before upload can be finished
Precondition(s)	Geo datasets are in ESRI Shapefile data format. Tables are in tab delimited data format If national data are not in DRB GIS database schema, then schema mapping has to be done in advance.
After fulfillment	Update of data repository is starting.
Comment(s)	First the dataset, which can consist of multiple files, is checked whether all the necessary files are provided. After that a comparison is carried out, if the data types of the columns and their names comply with the target schema. As last step the process tests whether all required fields are provided. As result a status message is shown.

Activity Diagram: Data Validation (AC_221)

ID: AC_221	**Activity Diagram to Sub Use Case Data validation (UC_22): Starts validation procedure**
	
Comment(s)	The validation process may differ depending on which dataset is uploaded.

ANNEX D: SUPPORTED GEOGRAPHIC COORDINATE SYSTEMS

ETRF 1989

GEOGCS["GCS_ETRF_1989",DATUM["D_ETRF_1989",SPHEROID["WGS_1984",6378137.0,298.257223563]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]]

ETRS 1989

GEOGCS["GCS_ETRS_1989",DATUM["D_ETRS_1989",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]]

WGS1984

GEOGCS["GCS_WGS_1984",DATUM["D_WGS_1984",SPHEROID["WGS_1984",6378137.0,298.257223563]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]]

ANNEX E: WORKPLAN

ANNEX E: WORKPLAN