Reference Information Specifications for Europe (RISE)
Specific Support Activity SSA3-2005-012141
Project co-funded by the European Commission within the 6th Framework Programme (2002-2006)
Integrating and Strengthening the European Research Area – Priority 4: Aeronautics & Space

Use Case Document 'Diffuse nutrient leakage reporting to the Water Framework Directive' Version 1.5

Deliverable number: 18 [3.2.1]
Date: 28 September 2007

© RISE 2007 - Distribution: PP

Project started: 1st September 2005
Duration: 27 months

Project Coordinator: Nick Land, EuroGeographics

Bundesamt für Kartographie und Geodäsie

Customer:	European Commission
Customer Reference:	Contract FP6-012141
Project Title:	RISE: Reference Information Specifications for Europe
Document Title	Use case document 'Diffuse nutrient leakage reporting to the Water Framework Directive'
Principle Author	Christine Brönner
Principle Contributors	Dominique Laurent (IGN), Lars Stalsberg (NVE), Jakob Nisell (SMHI), Vincent Mardhel (BRGM)
Responsible Partner	OGCE
Reviewed By	RISE PCMG
Approved by	Nick Land
Filename	RISE18_Use_Case_Document_V1.5
Distribution	PP
Contact	http://www.eu-rise.org/ Christine Brönner, cbroenner@opengeospatial.org Martin Klopfer, mklopfer@opengeospatial.org

© Copyright RISE 2007.

This document has been prepared for use by the RISE Project Partners. It can be used or disseminated consistent with the document classification given on the front page (see coding below).	
PU	Public
PP	Restricted to other programme participants (including the Commission Services)
RE	Restricted to a group specified by the consortium (including the Commission Services)
CO	Confidential, only for members of the consortium (including the Commission Services)

Revision History			
Version	Author(s)	Date	Comments
Draft V1	Christine Brönner	2006-06-23	1st draft for review by RISE consortium
Draft V2	Christine Brönner (ed.), Jakob Nisell (SLU), Ylva Westman (SMHI), Anders Gyllander (SMHI)	2006-08-25	Completion of Hydrography, landcover and elevation data input processing for the Swedish scenarios. Reference to Euroharp for landcover data processing in the frame of nutrient leakage modelling following RISE meeting in Paris on 18-05-2006 and Telcon on 20-07-2006.
Draft V3	Christine Brönner (ed.), Lars Stalsberg (NVE), Daniel Björkert (SMHI), Dominique Laurent, Mike Gould	2006-10-31	Addition of Norwegian use case scenario descriptions following Swedish/Norwegian crossborder use case meetings, Stockholm/Arlanda, 28-08-2006 and 27-09-2006. Integration of SDIGER WFD Reporting use case analysis. Initial consideration of the French DEM processing scenario following Telcon on 16-10-2006.
V1.0	Christine Brönner (ed.), Lars Stalsberg (NVE), Ariane Blum, Vincent Mardhel, Dominique Laurent, Clemens Portele	2007-02-05	Review of Norwegian landcover scenario to include TEOTIL2 reference. Addition of Norwegian landcover checklist. Inclusion of French DEM processing use case scenario. General revision of content. Revision of checklists following Telcon on 08-01-2007 and comments provided by Andreas Illert, Morten Borrebaek and Clemens Portele.
V1.1	Christine Brönner (ed.), Martin Klopfer (ed.), Wyn Cudlip	2007-03-05	Additional explanatory text by Wyn Cudlip Final review
V 1.2	Martin Klopfer (ed.)	2007-03-19	Editorial Revision & Approval by WP Leader
V 1.3	Christine Brönner (ed.)	2007-07-20	Document revision based on comments by Michael Stjernholm (National Environmental Research Institute, University of Aarhus/Denmark), external reviser for the EC.
V 1.4	Martin Klopfer (ed.)	2007-07-31	Final QA review with minor edits.
	Christine Brönner (ed.)	2007-09-07	Minor edits based on final comments by Jörgen Hartnor, and Helen Eriksson
V1.5	Christine Brönner and Martin Klopfer (eds.)	2007-09-28	Reference numbering. Following Telcon on 10-09-1007: additional explanatory text concerning spreadsheet entries in light of the iterative approach of RISE.

Executive summary

The overall aim of the RISE Project is to facilitate the production of harmonised Data Product Specifications. One of the specific objectives of the work has been the production of the document: Methodology & Guidelines on Use Case and Schema Development. This defines a repeatable methodology for developing, adapting and maintaining Data Product Specifications.

The key aspect of the RISE Methodology is to use a Use Case analysis to identify specific data harmonisations requirements (e.g. common terminology, co-ordinate reference systems etc.) from the general user requirements an application poses (e.g. the need for a harmonised WFD reporting for surface water bodies). The Use Case analysis aims at providing the necessary understanding of relevant data sources and models, actors and their interactions, and the workflows towards meeting the user requirements posed by an application. The process involves an 'as-is' analysis followed by a gap analysis and a definition of a harmonisation approach. These activities combined assist a harmonised Data Product Specification to be defined. The RISE Methodology provides a Use Case Template and a Checklist Spreadsheet addressing specifically the data harmonisation components laid out by the RISE Methodology and Guidelines to help with that analysis.

The Use Case Document presented here gives a working example on the use of the RISE Methodology and Guidelines to develop a RISE Use Case based on Diffuse Nutrient Leakage Reporting to the Water Framework Directive. That issue and other topics were implicitly included in the frame of the requested River Basin characterisation that had to be carried out by all EU Member States for the first time in 2005 under a limited set of requirements. Guidelines for the next reporting in 2010 are under revision by the relevant working groups.

RISE does not address the whole issue of Diffuse Nutrient Leakage reporting; rather, it addresses the issues associated with harmonising some of the input datasets required as part of the overall process. RISE has chosen the themes of hydrography, landcover and elevation to generate examples of the use of the RISE Methodology to develop harmonised Data Product Specifications covering these three themes. These components are relevant to Diffuse Nutrient Leakage reporting and also to the INSPIRE 'priority common basic data' list and to many GMES applications.

The real world Use Case scenarios are described for Sweden, Norway, including the cross-border aspects between these two countries, and France.

It is noted that there are already some crossborder and cross-sector experiences in the WFD reporting context from the INSPIRE related SDIGER project involving France and Spain. The present document looks at which of the data harmonisation components specified by RISE have been dealt with in the SDIGER project and how these were handled.

The RISE methodology assumes that there is a clear user-driven overall harmonisation requirement and that the application-specific harmonisation requirements can be determined during the Use Case Analysis. In practise, particularly at this stage of the development of the WFD reporting requirements, the overall harmonisation requirements are not well defined and so RISE has had to make some assumptions following the iterative approach of the RISE Methodology when a clear requirement was not defined. Also, the data sources employed for the analyses in the various countries are often not well documented in terms of the data harmonisation components and this expertise is not always readily available. These two factors highlight that the development of specifications for harmonised data products will be a challenging task in the foreseeable future.

The RISE approach for the development of harmonised data product specifications is designed around spiral engineering, driven by the availability of relevant information. Ideally, an iteration of this first spiral development loop should be carried out, which is expected to lead to a refined harmonised data product specification for the application of the nutrient leakage modelling in question. This iteration would take into consideration the experiences gathered so far, require the availability of a more thoroughly defined set of requirements and appropriately documented data, and possibly draw from a broader base of countries involved in the reporting.

Table of contents

Abbreviations

Bioforsk	Norwegian Institute for Agricultural and Environmental Research
BRGM	Bureau des Recherches Géologiques et Minères
CA	Competent Authorities
CIS	Common Implementation Strategy
CRS	Coordinate Reference System
DEM	Digital Elevation Model
EC	European Commission
EU	Eurpean Union
EUROHARP	Towards European Harmonised Procedures for Quantification of Nutrient Losses from Diffuse Sources
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
GML	Geographic Markup Language
GRID Arendal	Global Resource Information Database (UNEP in Arendal/Norway)
hDPS	harmonised Data Product Specification
HELCOM	Helsinki Commission
IAKS	Jordbruksverkets administrativa register för arealbaserade stöd (Croparea database)
IDPR	Indice Développement Persistence des Réseaux
IGN	Institut Géographique National (France)
INSPIRE	Infrastructure for Spatial Information in Europe
ISO	International Standards Organisation
IVL	Svenska Miljöinstitutet (Swedish Environmental Research Institute)
JOVA	Programmet for JOrd- og Vannovervåking i landbruket (Surveillance Programme on Soil and Water in Agriculture)
JRC	Joint Research Center
N	Nitrogen
NIJOS	Norwegian Institute of Land Inventory
NIVA	Norwegian Institute for Water Research
NTF	Nouvelle triangulation de la France

NVE	Norges vassdrags- og energidirektorat (Norwegian Water and Energy Directorate)
OGCE	Open Geospatial Consortium Europe
OSPAR	Oslo-Paris Commission (for the protection of the North Sea)
P	Phosphate
PLC	Pollution Load Compilation
RB	River Basin
RBD	River Basin District
REGINE	REGIster for NEdbørfelt i Norge (National Hydrometic System in Norway)
SANDRE	Service d'Administration Nationale des Données et Référentiels sur l'Eau (France)
SCB	Statistiska Centralbyrån (Statistical Bureau of Sweden)
SDI	Spatial Data Infrastructure
SDIGER	Spatial Data Infrastructure for Adour-Garonne and Ebro River basins
SK	Statens Kartverk (Norwegian Mapping Agency)
SLU	Sveriges Lantbruks Universitet (Swedish Agricultural University)
SMED	Svenska Miljö Emissions Data (Swedish Environmental Emission Data)
SMHI	Sveriges Meteorologiska och Hydrologiska Institut (Swedish Meteorological and Hydrological Institute)
SOSI	Service Orienteret System Integration (Norway)
SVAR	Svenskt Vattenarkiv (Swedish Inland Waters database)
SYKE	Suomen ympäristökeskus (Finnish Environment Institute)
TRK	Transport, retention och Källfördelning (Transport, Retention and Source apportionment)
WFS	Web Feature Service
WFD	Water Framework Directive
WISE	Water Information System for Europe

Reference documents

[1] Arheimer B. and Brandt, M. (1998): Modelling Nitrogen transport and Retention in catchments of Southern Sweden. In: Ambio, Vol 27, No 6, pp 471-480.

[2] Common Implementation Strategy for the Water Framework Directive. Policy Summary to Guidance Document No. 9: Implementing the Geographical Information System Elements (GIS) of the Water Framework Directive. Working Group 3.1-GIS.

[3] EC-DG Environment D.2: 2005 Reporting guidance, 19 November 2004

[4] EC-DG Environment D.2: 2010 Reporting guidance (draft), June 2006.

[5] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2003 establishing a framework for Community action in the Field of water policy. Official Journal of the European Commission L 327/1, 22 December 2000.

[6] EUROHARP Description of work, EVK1-CT-2001-00096, December 2001.

[7] Mardhel V. and Gravier A. (2005): Carte de vulnérabilité simplifiée du bassin Seine-Normandie. Rapport BRGM/RP- 54148-FR.

[8] Panagos, P.and M. van Liederkerke (2004): The Euroharp information system, JRC Publication EUR 21374EN.

[9] RISE Methodology & Guidelines on Use case & Schema Development. Version 1.1, September 2006.
http://www.eu-rise.org/ or http://www.eurogeographics.org/eng/03_RISE_downloads.asp

[10] Schoumans, O.F. & Silgram, M. (eds.), 2003. Review and literature evaluation of Quantification Tools for the assessment of nutrient losses at catchment scale. EUROHARP report 1-2003, NIVA report SNO 4739-2003, ISBN 82-557-4411-5.
http://www.euroharp.org/toolbox/qt_doc/eh-report1-WEB.pdf

[11] SDIGER: http://www.idee.es/sdiger/

[12] Selvik, J.R. et.al. (2003): Input of Nutrients to Norwegian coastal areas in 2003, calculated with the input-model TEOTIL2. Norwegian Institute for Water Research (in Norwegian with English summary).

[13] SMHI -The HBV-NP model: http://www.smhi.se/sgn0106/if/hydrologi/hbv_np.htm

[14] Vogt, J. (ed.) December 2002: Implementing the GIS elements of the Water Framework Directive. Guidance Document. JRC Publication EUR20544 EN.
www.ec-gis.org/docs/F2305/GIS_GD.pdf

[15] TRK model: http://www-nrciws.slu.se/TRK (in Swedish)

[16] WISE (Water Information System for Europe):
http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm

1. Introduction

The key aspect of the RISE Methodology is to use a Use Case analysis to identify specific data harmonisations requirements (e.g. common terminology, co-ordinate reference systems etc.) from the general user requirements an application poses (e.g. the need for a harmonised WFD reporting for surface water bodies). The Use Case analysis aims at providing the necessary understanding of relevant data sources and models, actors and their interactions, and the workflows towards meeting the user requirements posed by an application. The process involves an 'as-is'" analysis followed by a gap analysis and a definition of a harmonisation approach. These activities combined assist a harmonised Data Product Specification to be defined. The RISE Methodology provides a Use Case Template and a Checklist Spreadsheet addressing specifically the data harmonisation components laid out by the RISE Methodology and Guidelines to help with that analysis.

The Use Case Document presented here gives a working example on the use of the RISE Methodology and Guidelines to develop a RISE Use Case based on Diffuse Nutrient Leakage Reporting to the Water Framework Directive. Reporting on that topic falls under the Directive's objective of achieving a good ecological status of water bodies in the Member States, and is relevant for the establishment of so-called River Basin Management Plans requested by the EC through the WFD. A first reporting on the River Basin characteristics including the ecological status had to be carried out by all EU Member States for the first time in 2005 under a limited set of requirements. The actual specifications for the 2010 reporting requirements are currently under discussion by the relevant working groups at national and EC level.

In 2010 more detailed information will be available for reporting in the Member States as compared to the situation in 2005, when the River Basin characterisation had to be reported. Regarding the future Diffuse Nutrient Leakage reporting, geospatial information will be requested specifically in 2010, whereas in 2005 only textual information on the issue had to be submitted. Guidelines for the next reporting in 2010 are under revision and it is hoped that the RISE Methodology will assist in addressing some of the 2010 reporting requirements.

It must be noted that RISE does not address the whole issue of Diffuse Nutrient Leakage reporting and related spatial data analysis; rather, it addresses the issues associated with harmonising some of the input datasets required as part of the overall process. RISE has chosen the themes of hydrography, landcover and elevation to generate examples of the use of the RISE Methodology to develop harmonised Data Product Specifications covering these three themes. These components are relevant to Diffuse Nutrient Leakage reporting and are also relevant to the INSPIRE 'priority common basic data' list and to many GMES applications.

The Use Case Analysis is performed for the scenarios in Sweden, Norway and France. Specific user-experts from these countries have been involved in the process. The use of the two Scandinavian countries has allowed both the cross-sectorial and the crossborder aspects to be addressed in the scenarios.

The Swedish and Norwegian approaches to processing input data for the Hydrography and Landcover themes have been used as examples; and these have been based on real user requirements whenever possible. The 'Elevation' theme is dealt with through looking at a French reporting example involving the generation of 'thalwegs'.

In an additional chapter, the SDIGER project is considered. SDIGER is an INSPIRE-related pilot project for the development of a Spatial Data Infrastructure (SDI) to support access to geospatial information resources concerned with the WFD for the Adour-Garonne and Ebro River Basins, within an inter-administration and cross-border scenario. The present document sheds a light on SDIGER in that it analyses which of the data harmonisation components RISE advocates have been dealt with in the project's use case 'Reporting by River Basin Districts within the WFD', and how they relate to the RISE methodology.

2. The WFD-Diffuse Nutrient Leakage Reporting context for RISE

2.1 The Water Framework Directive and the GIS Guidance document

The Water Framework Directive (WFD) 2000/60/EC of the European Parliament and of the Council of 23 October 2003 establishes a framework for Community action in the field of water policy. The main objectives of the legislative piece are to achieve a good status of water bodies in the European Union by 2015, the protection of these water bodies and the impediment of their deterioration [5]. Each Member State has to follow the WFD Guidelines for protecting and improving the quality of rivers, lakes and coastal waters, and reducing potential hazards such as flooding. The Member States are obliged to set up a process that leads to at least a good ecological status for water bodies in Europe and report according to the guidelines specified in the WFD. The EC on the other hand monitors the process and performance of the WFD implementation through the reporting requested.

The main spatial unit for the management of river basins the Directive refers to is the River Basin District (RBD). Article 5 of the WFD requests the reporting on the characterisation of the River Basin Districts and the analysis on pressures, impacts and water uses within. For each river RBD a so-called River Basin Management Plan will have to be established and updated every six years by the Competent Authorities (CAs) of the RBD. According to Article 5 of the WFD, such a plan is to be the detailed account of how the objectives set for the river basin (ecological status, quantitative status, chemical status and protected area objectives) are to be reached within the timeframe set by the WFD. The plan will include the river basins' characteristics, a review of the impact of human activity on the status of waters in the basin, the estimation of the effect of existing legislation, and a set of measures designed to meet the objectives [16].

For the implementation of the WFD, a Common Implementation Strategy (CIS) was developed by the Member States and Norway to provide a common understanding and awareness of the Directive. The key tools of the CIS are the so-called Guidance Documents to help the Member States with the WFD implementation. The WFD implementation requires spatial data analysis and presentation for the preparation of the River Basin Management Plans and as part of that the reporting requested by the EC. Consequently, the Guidance Document relevant for RISE is the one on GIS (WFD CIS guidance document no. 9), which covers the spatial data aspects [14]. This GIS Guidance Document has been issued in 2002 as a recommendation document currently under revision. It details the specifications of Hydrography data required for analysis and reporting for the various Articles in the WFD. The issue of the GIS Guidance document available to RISE addresses the preparation of geographic datasets for the production of maps on the River Basin characterisation requested by the WFD and their reporting to the EC, whereas spatial analyses for the preparations of the River Basin Management Plans are not yet tackled [2].

2.2 Diffuse Nutrient Leakage Modelling

Euthropication of fresh- and marine waters due to increased nutrient loads by various sources is a problem observed throughout Europe. Consequently, the Diffuse Nutrient Leakage modelling in the frame of the WFD is carried out towards the determination and improvement of the ecological status and potential of water bodies as part of the River Basin Management Plans. This topic chosen by RISE as basis for its use cases is a subset of WFD reporting. It refers to the Reporting Sheet 'Significant diffuse source pollution on surface waters' (Reporting Sheet Code SWPI 4) of the Reporting Guidance documents issued by the EC [3],[4]. Diffuse nutrient leakage modelling itself is complex, involving numerous parameters differing from member state to member state due to different environmental conditions addressed in various numerical models employed. The WFD does not spell out references for requirements for spatial data products as input for the diffuse nutrient leakage determination as such. To potentially derive a set of general common input data requirements for the nutrient leakage modelling throughout Europe, the EUROHARP project was studied. This project considered nine different contemporary methodologies used in various European countries for quantifying diffuse losses of N(itrogen) and P(hosphate), and a total of 17 study catchments across gradients in European climate, soils, topography, Hydrography and land use [6],[8],[10]0. EUROHARP, which aimed at facilitating the WFD implementation regarding N and P leakage aspects, did not establish a harmonised pan-European solution for the models that could have found its input into RISE though. Rather, RISE extracted user requirements for the relevant input data processing from models for nutrient leakage determination used by the various countries respectively, as will be outlined hereunder.

2.3 User requirements for the RISE Use Cases

The themes hydrography, landcover and elevation, which RISE focuses on within its scope, do play a role in nutrient leakage analyses in various degrees, since they form input parameters to the overall modelling. Common user requirements for the Member States on the selected reporting subset on Diffuse Nutrient leakage, which would in the RISE context facilitate the development of harmonised data product specifications for the application, cannot be deducted or established directly for model input parameters in the case of the landcover and elevation themes. Therefore, user requirements for the three themes in the nutrient leakage context have been assembled from various sources, and partly produced through iteration of the RISE spiral approach where user requirements for a harmonised data product specification development were missing.

In the present use case description, requirements for hydrography data are extracted from the WFD GIS Guidance document which reflects the definition of River Basin District and surface water body information requested in Article 5 and Annex II of the WFD.

The analysis referring to the landcover themes are based on current data processing which serves as input for the nutrient leakage modelling. Hence, the work that was carried out by the Member States was considered in the Use Case analysis towards landcover input data processing for established models employed for non-WFD reporting purposes. The scenario descriptions for landcover in the present Use Case document thereby are associated to those parameters, which are extracted as input for the N and P (numerical) modelling as part of well-established diffuse nutrient leakage models in use in Sweden and Norway respectively. These are the so-called TRK model in the Swedish [15][1] and the Teotil2 model in the Norwegian scenario. The TRK model is, among others, employed for the Pollution Load Compilation (PLC) compilation reporting to the Helsinki Commission (HELCOM) of the Baltic States as well. The Norwegian model, TEOTIL2 [12], is a versioning of TEOTIL whose original purpose was to obtain nutrient losses (N and P) in connection with the development of a plan for the North Sea Area to be able to achieve the goal of 50% reduction in the nutrient leakage discharge into the North Sea in the OSPAR area.

With regard to the elevation theme, there are no specific common requirements for the WFD reporting, within Euroharp or the nutrient leakage models employed by Sweden and Norway either. Therefore, for the elevation theme, user requirements have been deducted from a French case of input data processing, whose results are eventually included in the reporting to the WFD. The elevation information in question is the one required as input for the calculation of the Indice Développement Persistence des Réseaux (IDPR) [7]. This index is a simplified approach to approximate the tendency of a catchment to transfer water to groundwater (infiltration) or to surface water (runoff). In the French WFD reporting case, the index value finds its way into the assessment of the vulnerability of groundwater bodies to deterioration.

Actors in the current setup (i.e. in 2005) are in all countries entities, who are tasked with intermediate processing steps for the WFD reporting. These various entities provide data processed according to certain requirements derived from the WFD GIS Guidance document, TRK model, TEOTIL2 model, and Thalweg calculation as outlined before, which is then available for further processing (in models) where applicable. The actors and their interactions with the bodies requesting these intermediate products are described in chapters 4, 5 and 6 for each of the individual use case scenarios illustrated.

3. Methodology

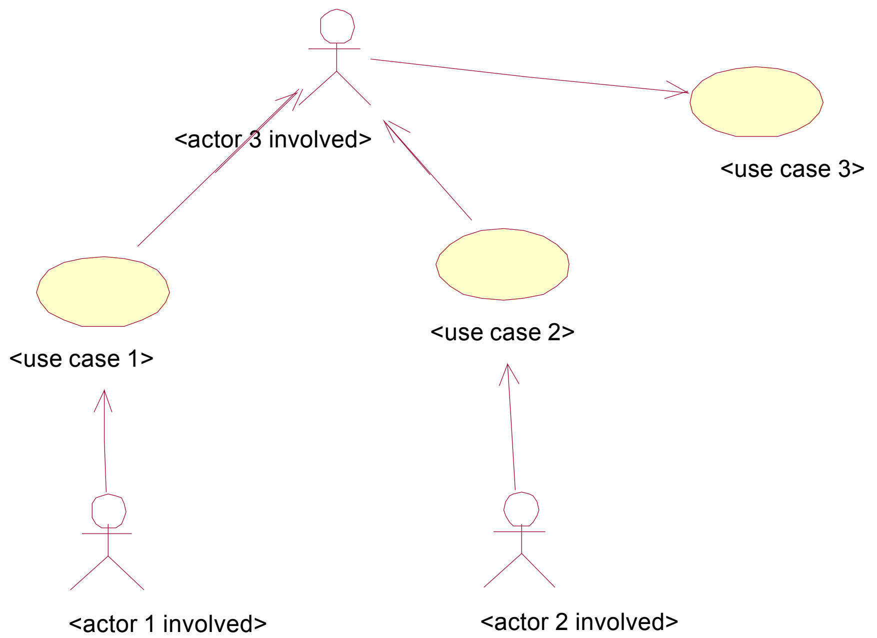
3.1 RISE Use Case Template

The RISE use case description is intended to provide the necessary understanding of the involved processes and workflows in an application scenario, with the aim of depicting the harmonisation issues at hand. To that end, the documentation of the use case is executed with a Use Case Template which forms part of the RISE Methodology introduced in the RISE Methodology & Guidelines on Use case and Schema Development (Version 1.1) document available at the time of executing the Use case analysis [9]. Any edits relevant to the Use case analysis carried out in following versions of the Methodology and Guidelines document would consequently be reflected when iterating the RISE spiral approach for the Use Cases described the next time.

The template comprises of three parts:

Part 1: A UML use case diagram to provide an overview of the use case(s) and the involved actors.

Example:



Part 2: A narrative explanation of the use case(s) in the form of a scenario description (in plain text format).

Part 3: A detailed, structured description of the use case in table format.

Table example:

Use Case Description	
Name	<name of use case>
Priority	<high/medium/low>
Description	<short description>
Pre-condition	<What are the pre-requisites from other use cases? What input is required?>
Flow of Events – Basic Path	
Step 1.	
…	
Step m.	
Step m+1.	
…	
Step n.	
Flow of Events – Alternative Paths	
Step m.	
Step m+1.	
Post-condition	<What is the output for other use cases? What are the anticipated next steps?>
Data source: <Name> *[repreat per data source]*	
Description	
Data provider	
Geographic scope	
Thematic scope	
Scale, resolution	
Delivery	
Documentation	

3.2 The RISE Checklist

The Use Case Template is accompanied by a Checklist (an Excel Spreadsheet) developed by RISE, which is structured according to the Data Harmonisation components identified in the RISE Methodology and Guidelines document. The checklist is an annex to the RISE Methodology & Guidelines document and is also provided for reference in the Annex to this Use Case document. The version used in the present document is the one from the RISE Methodology and Guidelines Document (Version 1.1) issued in September 2006. The Checklist provides, for each of the Data Harmonisation components, a column for the user requirements posed by an application, examines the actual data used in the various scenarios ('as-is-situation'), identifies the gap between the requirements and the as-is-situation, and supplies a column for harmonisation approaches to bridge any gap identified where applicable.

The information gathered in the Use Case Template, the Checklist and the references on e.g. existing documentation on the data included in the latter together are the basis for the development of a harmonised Data Product Specification.

The checklist in the present use case description is issued as per theme (i.e. hydrography, landcover, elevation) for the scenario in each country and presented in the document annex (Chapter 9). It has been compiled based on the experience gathered when conducting interviews with the various domain experts. The Checklist does consider the fact, that an iteration of the RISE spiral might extend and enrichen the information which was available for the various harmonisation components at the time of the interviews carried out with the Use case stakeholders. Hence, in the column ‘Harmonsiation approach’, the actual stage of the harmonisation approach is reflected where applicable as ‘To be done’ or ‘In progress’. These indications will be helpful when revisiting the Use case analysis.

4. Hydrography Use Case Scenario

4.1 The hydrography scenario in Sweden

4.1.1 Introduction

The WFD reporting in Sweden is carried out by the SMED (Swedish Environmental Emission Data) consortium under the guidance of the Swedish Environmental Protection Agency. The consortium is composed of the Swedish Meteorological and Hydrological Institute (SMHI), the Swedish Agricultural University (SLU), the Swedish Environmental Research Institute (IVL) and the Swedish Bureau of Statistics (SCB). Each of these entities composing the consortium supplied and/or processed data for the 2005 reporting which were back then exchanged for the purpose of the WFD reporting via a consortium ftp server. Information for the present use case description has been mainly obtained from the Swedish Meteorological and Hydrological Institute which was in charge of processing the hydrological data for the WFD reporting and eventually submitted all the information to the EC.

4.1.2 Hydrography input data processing

This section describes the Swedish approach of processing Hydrography input data for surface water body reporting to the WFD. Considered are those requirements and steps which provide the hydrological features to which the diffuse nutrient leakage as part of the ecological status reporting of surface water bodies to the WFD is referred to.

The WFD requires:

- The provision of River Basin District overview information

  Requested by the WFD are data on River Basin Districts and their catchments, the River Basins and primary catchments (the smallest units in the catchment hierarchy). These units have to carry name and a unique national code, and are to be equipped with a European one as indicated in the GIS Guidance Document of the WFD.

  Sweden has five River Basin Districts and spatial information on water features is kept as per these units. Four different types of surface water bodies are stored separately as per River Basin district: Rivers in that database are available in line format, the lakes and widening rivers parts as polygons, and transitional and coastal waters as polygons.

  Aggregations of the catchment areas find their input into the Swedish diffuse pollution modelling employed in the P and N leakage quantification part employed for the WFD reporting, in that landcover and elevation information is referenced as per these aggregated units.

- The categorization of surface water bodies

  This characterization of surface water bodies comprises of the assignment of a unique national and European code for each surface water body feature, a name and the categorization of each surface water body into one of four given classes. The structure of the national code is thereby up to each member state, the code itself is extended into a unique European feature code required by the WFD. Surface water bodies are to be categorized into Rivers, lakes, coastal waters and transitional waters.

In 2005, no further processing of the spatial hydrological data was required for the WFD reporting; the files produced were picked up directly by the WISE reporting specialist for reporting to the WISE prototype portal and the specific information to be reported was extracted and submitted to the portal.

The Scenario:

To create the overview information for the River Basin Districts according to the WFD requirements, the GIS expert retrieves the River Basin District and River Basin catchment files available in-house from the GIS server. The five River Basin Districts (RBD) in Sweden contain ca. 12000 primary catchments, i.e. catchments with a size > 40 km^2. Due to the large number of rivers and lakes in Sweden, the average catchment size of 10 km^2 , fixed by the WFD, is considered as not workable in the Swedish context. Instead, the present catchment size is maintained.

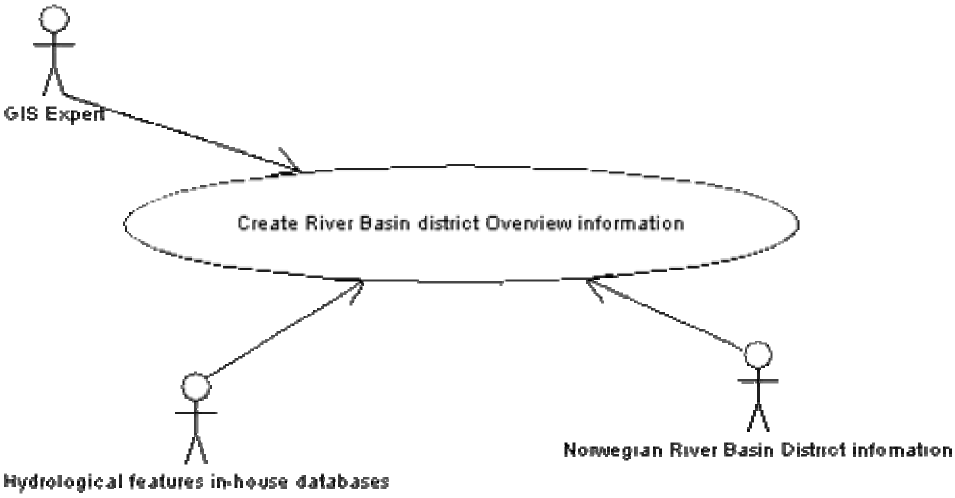
In order to assign the River Basin District European Code, each of the five River Basin District files available for Sweden is opened and the column for the European code added and filled in manually (from 1-5) respectively. The basis for the order is the national ID which is available already for each District, as well as the name of the River Basin District.

The catchment data available as per River Basin District already holds attributes like the name as well. The unique national code as required by the WFD is composed in a new column created in the attribute table from the combination of attributes available per catchment. Equally to the River Basin District, a new column for the European code is added to the attribute table, the national code of the catchments copied into that column and the prefix of the code added to the unique national code through applying a routine.

As not all ca. 13000 surface water bodies selected for the WFD reporting have a catchment area delineation in the catchment database yet, updating for another 3000-4000 catchments is performed continuously in the catchment database through on screen digitizing.

Edgematching of catchment delineations within the national territory for cases where the catchment partly has its source in Norway, but covers Swedish territory and vice versa is carried out. In order to do so, the GIS expert opens the Norwegian vector data received in a compressed file via email. The polygon file contains the Norwegian River Basin Districts and catchment delineations. Re-projection has to be performed between the two datasets. Then, the Norwegian River Basin districts along the border are selected and joined with the Swedish dataset. In editing mode, edge-matching between the River Basin Districts is performed manually along the border line through retouching nodes; names of catchments draining from Norway into Sweden are taken from the Norwegian dataset.

Creation of River Basin District Overview Information (Sweden)



Use Case Description	
Name	Creation of River Basin District overview information
Priority	High
Description	Catchment areas and River Basins are delineated and equipped with a unique national feature code, the name and a European code where applicable.
Pre-condition	Spatial data on River Basin Districts and catchments is available along with the names of the units. The WFD requirements are known, as well as the rule for the creation of the European code. A national coding system for the catchments is in place.
Flow of Events – Basic Path	
Step 1.	User retrieves River Basin District and catchment files as per River Basin District and opens attribute tables.
Step 2.	Columns for European code in River Basin District attribute table are added, the code typed in manually and saved.
Step 3.	In the catchment attribute table, the user creates a new column for the unique national ID and composes the code from existing attributes. Also, a column for the European code is created and the national code copied with the European prefix. The attribute table is saved.
Step 4.	The file with the Norwegian catchments at the border with Sweden is opened and reprojected.
Step 5.	User edgematches in edit mode the Swedish with the Norwegian catchment boundaries.
Flow of Events – Alternative Paths	
Step 2.	Names of river basin district are missing.
Step 4.	Reprojection does not result in matching data.
Post-condition	River Basin Districts and catchment areas within River basins are available and equipped with feature attributes corresponding to the ones indicated in the WFD.

Use Case Description	
Data source: River Basin Districts of Sweden	
Description	The data was produced through manual digitizing the sketched catchments and River Basin District boundaries from 1: 50 000 Topographic paper maps provided by Lantmäteriet.
Data provider	SMHI
Geographic scope	Sweden
Thematic scope	Catchment, River Basin and River Basin District delineation.
Scale, resolution	1: 50 000 and 1: 100 000 (mountainous areas)
Delivery	The files are available as polygon layers as per River Basin District.
Documentation	N/A
Data source: The Norwegian National Hydrometric System (REGINE)	
Description	The REGINE catchment database for Norway was produced through manual digitizing of watershed lines from topographic maps in 1: 50 000.
Data provider	NVE
Geographic scope	Norway
Thematic scope	A hierarchical hydrometric system of catchments for hydrological analysis, supporting water and hydroelectrical management systems.
Scale, resolution	1: 50 000
Delivery	Digital (compressed file via email)
Documentation	N/A

For the Surface Water Body categorization, the GIS expert loads the vector layers holding the Hydrography vector data in the database present in-house from the local GIS server onto his/her machine and opens the files in a vector handling tool. These files comprise of information on the categories to be reported to the WFD, namely lakes, rivers, coastal waters and transitional waters.

For the reporting, the watercourses longer than 10 km and lakes greater the 1 km² (WFD: > 0.5 km²) and the watercourses connecting the lakes with the rest of the system are selected in the respective file. This selection criterion does not follow the WFD rule but is a consequence of the large amount of Surface Water bodies in Sweden. The selection operation amounts to about 13000 surface water bodies.

Also, the associated attribute tables present in the Hydrography database are opened for each of the files, and new columns called WFD_ID for the national code and the name of the water body are defined following the WFD requirements. Consecutively, the unique European code is created through automatically assigning the prefix for Sweden to the unique national code of each feature in a new attribute column.

To assign a unique code to each river in the line layer, a routine program developed extracts the x/y coordinates of the source point of a river and merges them into a string. In case of a river tributary, the main river is divided into segments at the inlet point and the number 1 is added to the coordinates of the source of the main river. Rivers are also segmented when flowing through a lake. The routine produces the code and adds it as a new attribute in the attribute table.

The lakes in the polygon file receive a unique code based on the Swedish Inland waters database (SVAR). Through automated processing, lake outlet coordinate points are extracted from that database, holding the coordinates in an ASCII file. Due to a scale mismatch between the Inland Waters database (1: 50 000) and the Hydrography coverage (1: 250 000), the lake IDs are corrected retrieving actual values from the SVAR database point coordinate displayed on top of the Hydrography database. Codes are corrected manually where applicable as a result of that overlay.

The surface water body characterization for Coastal and transitional waters is carried out taking data from the Baltic Sea basin database. The area of Sweden to be reported to the WFD contains the archipelago and the external sea basin up to 12 nautical miles from the coastline, while the Baltic Sea basin database contains the entire Baltic Sea, the Kattegatt and Skagerrak. For reporting, the GIS expert selects those polygons covering the areas to at least 12 nautical miles from the coastline from the database and saves them into a new layer. As the Swedish territorial border is not included in the Baltic Sea basin database, the polygons extracted are cut with the 12 miles Swedish territorial border compiled from the Swedish General Map. Those polygons falling outside the territorial border are removed, the remaining ones manually receive a national code in the attribute table.

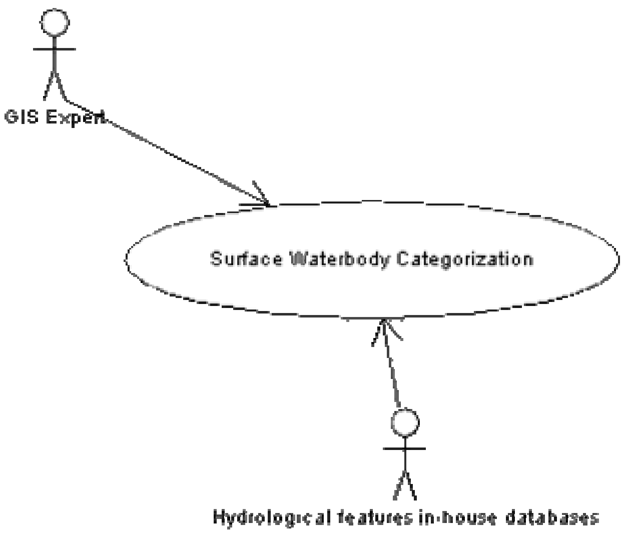
The files and attribute tables of all surface water bodies in each River Basin District are saved under a new name, following the file naming convention proposed by the WFD, and all files (rivers, lakes, transitional waters, coastal waters) send to the local GIS server.

After all surface water bodies have received a unique national code, the European code of each water body is created through collating the member state's prefix to the national code. In order to do so, the WISE reporting specialist downloads files from the local GIS server and opens the files and their associated attribute tables. Then, the attribute column WFD_ID from the operation of assigning a national feature code is copied and renamed into EU_CD as indicated in the WFD guidelines. In that column, all national codes are then equipped with the Swedish prefix.

Also, the new attribute columns of the WFD category for a surface water body and status year (i.e. year of reporting of waterbody characterization) of each surface water body are created. The attribute 'Category' in the WFD Reporting requirements thereby comprises of the classes RW (River Waters), LW (Lake Waters), CW (Coastal Waters) and TW (Transitional Waters).

The attribute table of all files are saved prior to extraction of information for submission to the WISE portal. As the surface water bodies are stored and treated as per River basin District, the file names get as an extension the number of the River Basin District the data refers to.

Surface Waterbody Categorization (Sweden)



Use Case Description	
Name	Surface Water Body categorization
Priority	High
Description	Surface water bodies are grouped into four categories as indicated by the WFD requirements. A unique national feature code is assigned to surface water bodies, along with other attributes. The national feature code is then expanded to a European code.
Pre-condition	Spatial data on surface water bodies at the required scale is available, their categorization is known. Names of surface water bodies are available. A national coding system for surface water bodies is in place. The rules for the European code creation and the attributes requested by the WFD are known.
Flow of Events – Basic Path	
Step 1.	The river (line), and lake, costal waters and transitional waters (polygon) files are loaded and visualized.
Step 2.	The attribute table of the files is accessed and a new column for the unique national feature code following the WFD specification is added by the user.
Step 3.	User selects river segments in the line layer and runs the code assignment tool.
Step 4.	User imports the ASCII point file of the Inland Waters database and visualizes the points on top of the lake polygons.
Step 5.	User assigns lake codes by taking the coordinate code from the Inland waters database (SVAR).
Step 6.	User opens the polygon files holding the Coastal and transitional waters and adds the column for the European code to the attribute table.
Step 7.	In all attribute tables (lakes, rivers, coastal waters and Transitional waters) the user adds a new column for the EU feature code, the status year of reporting and the Category of the surface water body to all attribute tables.
Step 8.	User copies all national codes to the European code column, applying a routine to add the member state prefix to each code automatically.
Step 9.	Status year and category information is entered into the attribute tables.
Flow of Events – Alternative Paths	
Step 3.	The code assignment tool is not assigning actual values.
Step 5a.	Lake coordinate point and lake have no spatial match.
Step 5b.	User crosschecks lakes in the layer and for mismatches with the Inland Water database types the corresponding national code value as visualized for that lake from the lake coordinate data into the attribute cell after selecting that lake.
Step 6.	Coastal and Transitional waters do not match with surface water body data.
Post-condition	Each surface water bodies is categorized according to River Waters, Lake Waters, Coastal Waters and Transitional Waters according to the WFD Guidelines, carries a unique national code and the attributes required by the WFD. The file names follow the convention proposed by the WFD.
Data source: Hydrological data from General Map	
Description	Surface Water bodies: Rivers, lakes, Coastal waters, Transitional Waters
Data provider	Originally obtained from Lantmäteriet
Geographic scope	Sweden

Use Case Description	
Thematic scope	Hydrography: Watercourses that are longer than 5 km and have a catchment area greater than 1 km^2
Scale, resolution	1:250 000
Delivery	Originally: Coverages on CD, files stored in in-house database.
Documentation	General Description of GSD-the General Map, version 3.0, 09-09-2004 (Lantmäteriet)
Data source: Inland waters database (SVAR)	
Description	The Swedish Inland Waters database (SVAR) is an ASCII point database, reflecting the coordinates of lake outlet points and those of river widenings, an ID of that point, as well as the lake depth. The database contains coordinates of ca. 100 00 lakes.
Data provider	SMHI
Geographic scope	Sweden
Thematic scope	Lake coordinate database
Scale, resolution	1: 50 000
Delivery	Info table in ASCII format, SVAR is a separate database within SMHI
Documentation	Printed lists of lake coordinates
Data source: Baltic Sea database (Havsområdesregistret)	
Description	Basins of the Baltic Sea area, refined with the 12 nautical miles zone around Swedish coastline.
Data provider	SMHI
Geographic scope	Baltic Sea countries
Thematic scope	The Baltic sea database comprises of the area depiction of the basins for the sea areas in Sweden. For use in Sweden, various datasources like depth information for the Swedish archipelago from the Swedish Maritime Administration have been added on.
Scale, resolution	1: 1 000 000, refined with information at 1: 250 000.
Delivery	Polygons stored in in-house database.
Documentation	Report: ‘Djupdata för havsområden 2003’” (in Swedish).

4.2 The hydrography scenario in Norway

4.2.1 Introduction

Norway did not officially submit a WFD report in 2005 unlike the EU Member States which were obliged to do so. Norway has been participating in setting up the Common Implementation Strategy (CIS) for the WFD though, and advanced the activities for reporting according to the WFD requirements under the guidance of five national Ministries. The actual hydrological data processing is the responsibility of the Norwegian Water and Energy Directorate (NVE).

4.2.2 Hydrography input data processing

Like in the Swedish case, this section describes the Norwegian approach of processing Hydrography input data for surface water body reporting to the WFD according to the requirements summarized in chapter 4.1.2.

- The provision of River Basin District (RBD) overview information for Norway refers to the nine River Basin Districts the country comprises of. Spatial information on water features is coded as per these units. These nine RBD cover 262 River Basins with about 20200 primary catchments.

- For the categorization of surface water bodies in Norway, only three categories of the four spelled out in the WFD are considered, as in Norway the category 'Transitional waters' is non-existent.

The Scenario:

To create the overview information for the River Basin Districts according to the WFD requirements, one national RBD polygon layer is created by using an automatic routine (Phyton script). Since the primary catchment areas in the Norwegian Water Information System, REGIster for NEdbørfelt i Norge (REGINE) are the origin for the reporting units (River Basin Districts, Competent Authority, River Basins) of the WFD, the attribute table of the REGINE has been updated to contain columns for all EU codes needed. All catchments have got a RBD code according to which RBD they belong. When running the Phyton script all catchments with a common RBD code are merged to create a RBD polygon. The reason for this routine is the continuous updating of the watershed lines. When a catchment changes in area the RBD polygon layer is updated every time the routine is run (not at a regular frequency but according to need). The same routine is applied for all layers building on REGINE. The RBD layer and all other administrative layers used for the WFD are stored in one central ArcSDE database at the Norwegian Water and Energy Directorate (NVE) and served to the Competent Authorities (CA) via Internet and Arc GIS Server.

In addition to the RBD layer a national layer is created consisting of 262 River Basins with an average size of 1650 km^2, according to Article 3. This layer is based on REGINE's catchments, which have an average size of about 21 km^2, corresponding to ca 20200 units for the whole country. There will be no further subdivision of catchments because of the directive. Norway uses a river network for delineating river water bodies, not the catchments themselves. Tools for upstream analysis will be employed on the river network for calculating area sizes etc.

The REGINE layer has got a unique national hierarchical code for each catchment. In addition to information about its River Basin code, name, area, runoff and other hydrological data the layer has got columns in its attribute table for national and EU codes for RBD, River Basins and Competent Authority. The EU River Basin code is composed of the national prefix plus the upper hierarchical catchment code (e.g. NO002). The Competent authority code is composed of the national prefix plus the respective authority code (e.g. NO0100). The codes are created by using calculation tools in GIS.

In order to assign the RBD code, the nine[1] RBD polygons for Norway are given a code manually, composed of the Pfaffstetter code given by the JRC for the Ecoregions and a digit running from the Swedish border and up north (e.g. 5101). The EU RBD code is created by adding the national prefix in front of the national RBD code (e.g. NO5101). The name of the RBD is added to the attribute table in Norwegian and English. International RBD polygons draining from Norway to Sweden and Finland are given the EU RBD code in the EU code column and name for the respective RBD on the other side of the border and vice versa, e.g. Bothnian Bay, NOSE1 for catchments running from Norway to Sweden and Glomma SENO5101 for catchments running from Sweden to Norway. These codes will constitute the EU RBD code for these cross border polygon areas. Vice versa, catchments draining from Norway into neighbouring contries get the Norwegian name and codes.

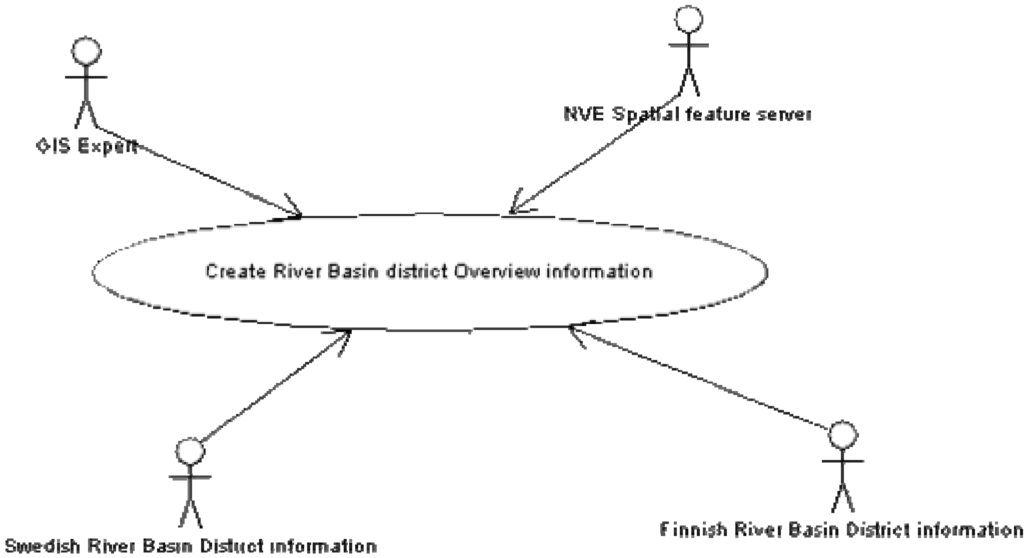
Edge matching of RBD delineations between the national territories of Norway and Sweden, where catchments partly have their source in Norway and vice versa, has been done in cooperation between the national GIS experts. In order to do so, the Norwegian GIS expert sent the Norwegian polygon data clipped with an agreed national border in a compressed file via email. The Swedish GIS expert projected the national polygon layer to UTM33, Euref89 and then the RBD delineation lines were snapped manually to the Norwegian ones at the border. The reason why the Swedish lines were snapped to the Norwegian ones was that the Norwegian data is at scale 1:50 000 and the Swedish at 1:250 000. EU RBD codes and names were controlled and added to the respective cross border polygon areas on both sides of the border. The finished composite polygon layer were then sent back to Norway via e-mail, checked, loaded into the WISE template and then uploaded to WISE by Norway.

The RB layer has not been through the same edge matching process as the RBD layer, since Sweden and Finland have not prepared the corresponding data. The Norwegian RB layer contains complete RBs with the Swedish/Finnish and Russian parts included. There is cooperation between SMHI on the Swedish side, the Finnish Environment Institute (SYKE) and NVE on the Norwegian side to match watershed lines across borders, but until now there has been no edge matching with common nodes. This is task should be planned and carried out in the same way as the ongoing edge matching of rivers between Sweden and Norway (see Surface Water Categorisation scenario).

Since there is a continuous updating of REGINE as a result of new contour constructions from the mapping authorities there will be need for routine edge matching between Norwegian and Swedish catchments. This affects the layers derived from REGINE. Norway addresses its national updating of the derived layers by routinely generate new ones from REGINE. This does not solve the problem of edge matching until an automatic routine is developed.

[1] Not decided yet.

Creation of River Basin District Overview Information (Norway)



Use Case Description	
Name	Creation of River Basin District overview information
Priority	High
Description	River Basins Districts (RBD) are delineated on the basis of the national catchment area layer (REGINE) and equipped with a unique national feature code, the name and a European code.
Pre-condition	Spatial data on catchments is available along with the designated codes and names of the RBD units. The WFD requirements are known, as well as the rule for the creation of the European code. A national coding system for the catchments is in place.
Flow of Events – Basic Path	
Step 1.	A RB/RBD dBase table is made manually containing the RB code (262 units) and the corresponding RBD code. The user ads column for the RBD code in the REGINE polygon layer and populates it by joining it to the RB/RBD dBase table.
Step 2.	The user then generates a national RBD polygon layer then generated on the basis of the REGINE layer by using the dissolve option with the RBD code as key.
Step 3.	The user adds columns for the national code, EU code and the name in the RBD attribute table and populates these manually.
Step 4.	The user generates the RB layer from the REGINE layer by using dissolve with the RB code as key.
Step 5.	In the RB layers' attribute table, columns for the unique national code and the EU code are created. The national code already exists as the three first digits in the Norwegian hydrometrical code system (001 → 247 draining to coast, 301 → 315 draining to border). The EU code is calculated by adding the national prefix in front of the RB code.
Step 6.	The user imports the already reprojected (by SMHI) RBD polygons from the RBD layer received from Sweden to a new Norwegian - Swedish layer in UTM33, Euref89.

Use Case Description	
Step 7.	The user runs through the lines on the Norwegian side of border and edits them where needed.
Step 8.	The user assigns codes and names manually to the polygons along the border on the Norwegian side.
Step 9.	The user exports the updated Swedish – Norwegian RBD layer as a Shape file for delivery to Sweden for edgematching and quality control of the coding and naming.
Step 10.	The edge matched and checked layer are received back from Sweden by email.
Flow of Events – Alternative Paths	
Step 5.	Reprojection does not result in matching data because of difference in scale. Norway use topographic data in 1:50 000 where Sweden use 1:100 000 (north Sweden). Or, projection is done without going via geographical coordinates.
Post-condition	River Basin Districts and River Basins are available and equipped with feature attributes corresponding to the ones indicated in the WFD.
Data source: The National Hydrometric System (REGINE)	
Description	The REGINE catchment database for Norway was produced through manual digitizing of watershed lines from topographic maps in 1: 50 000.
Data provider	NVE
Geographic scope	Norway
Thematic scope	A hierarchical hydrometric system of catchments for hydrological analysis, supporting water and hydroelectrical management systems.
Scale, resolution	1: 50 000
Delivery	All layers are produced and delivered as national layers in UTM 33, Euref89 and delivered as Personal Geodatabases, on Shape format and others on request.
Documentation	Metadata will be provided in winter 2006/2007: http://www.statkart.no/arealis/tema/faktaark/Natur/Faktaark_REG.html (in Norwegian).
Data source: Swedish River Basin District information	
Description	The data was produced through manual digitizing the sketched catchments and River Basin District boundaries from 1: 50 000 Topographic paper maps provided by Lantmäteriet.
Data provider	SMHI
Geographic scope	Sweden
Thematic scope	Catchment, River Basin and River Basin District delineation.
Scale, resolution	1: 50 000
Delivery	The files are available as polygon coverages as per River Basin District.
Documentation	N/A

The different Surface Water Body categories are created from hydrological vector layers. The river network layer for river water bodies originate from the line vector layer from the Norwegian Mapping Agency (spaghetti data). To produce the network, bifurcations have to be removed, bifurcated rivers have to be simplified to one line and gaps caused by lakes, river polygons, karst, urban areas and farming activities have to be closed. The gaps in the river layer caused by lakes and rivers delineated as polygons are closed by finding the centre line automatically with help of a program. Gaps caused by karsts, urban areas or farming activities have to be closed manually. These alterations result in a totally new layer with the river network that deviates from the original river layer. The river network layer is also used for purposes other than the WFD, so its attribute table contains other information in addition to WFD data. The water theme polygon layer from the Norwegian Mapping Authority is the original for the creation of layers for lake and coastal water bodies. All layers are derived from 1:50 000 originals. Norway does not use the transitional water body category. Norway has a total of 14000 surface water bodies; 7200 river water bodies, 4860 lake water bodies and 1830 coastal water bodies. All layers cover all RBDs and are stored in one central ArcSDE database at the Norwegian Water and Energy Directorate and served to the CA via Internet and Arc GIS Server.

Rivers crossing the border between Norway, Sweden, Finland and Russia will in future have to be tied together to produce a complete river network. This is needed to be able to define meaningful water bodies and to make correct hydrological and pressure/impact analysis. NVE has started to deal with this task by using the Swedish rivers as a test project. The Swedish river lines from the national water theme layer are projected to UTM33, Euref89 from RT90. The lines are then snapped to lake and river polygons and between gaps. The lake and river polygons are given a theme code to be able to run a program which calculates the centre line for these objects. The centre line for lakes get a lake theme and those for river polygons a river theme. The river polygons will then be represented as a line in the river network, whereas the centre lines through lakes will just function as a line connecting the network between inlets and outlets. When the snapping, editing and creation of centre lines are finished a program is run to create a network and to identify where problems like bifurcations exist. The program marks all irregularities, which the operator edits. When errors are removed lines are flipped towards the defined sink where the rivers cross into Norway. The Swedish network is then connected to the Norwegian part to form one complete river network, which is run through a procedure that orders all river segments according to the Strahler Stream Order. This Strahler Stream order will not be correct when run on only the Norwegian or Swedish part of the river network.
Lakes split by the national borders also constitute a problem since the national water theme layers for all countries only contain the part on their side of the border. The lakes from the Swedish national water theme layer are projected to UTM33, Euref89 and snapped to the Norwegian counterparts on the national border. In this way the correct area of the lakes will be available, an important attribute both for hydrological analysis and pressure and impact analyses. Since all lakes larger than 0.5 km² have to be defined as a water body, the area information for the border lakes is important. Lakes that have until now not been defined as water bodies will fall into that category when the Swedish part of the lake is added.

There are only two areas where the coastal water bodies are split by national borders; Iddefjorden towards Sweden and at the border to Russia where Grense Jacobselv has its outlet. Of these Iddefjorden is the most critical one, because of the pressure and impacts in the area.

These cross border water bodies have to be coded in accordance with an agreed system. There is no decision on how to code rivers running back and forth across the border or the lakes split on the border. Cross border lake and coastal water bodies should be reported to WISE with a common EU code, area, water type, pressure/impact and risk evaluation.

Water bodies are created according to WFD requirements. Rivers with a catchment area larger than 10 km² are delineated as a water body if they differ in water type and pressure/impact from tributaries and rivers within the same catchment area. Otherwise Norway does group rivers within the same catchment area where the water type and pressure/impact is the same. Rivers within such a grouped water body get the same water body code within a member state (MS_CD). In addition all river segments have a unique segment code. River water bodies do not get a name in this process, since the name for a group of rivers collected in one water body will not be one to one. The field for water body name will be populated by the user from autumn 2006 by using the Norwegian WFD management tool. As a substitute all water bodies have got the name of the river hierarchy they belong to in the attribute table in the column NameHirarchy. Lakes greater than 0.5 km² are delineated as water bodies and split in several water bodies where pressure/impact differs within the lake. Coastal water bodies are delineated according to water type and pressure/impact from the fjords to one nautical mile from the baseline. The name field in the coastal water body table has to be populated by the user from autumn 2006 by using the Norwegian WFD management tool as well.

The MS_CD is added to the attribute tables for each category in addition to other information (name, catchment area, runoff, etc). The code is defined according to the WFD requirement, which does not spell out rules for establishing the national code except for length and the field type; the composition of the EU MS_CD is requested as being based on the national code with the national prefix added. In addition name and other data is added to the attribute tables as specified by the WFD GIS Guidance Document. All codes are added to the attribute table automatically by using a WFD management tool (an Internet based tool using an ArcGIS Server to serve and deliver data from and to one single national ArcSDE geodatabase) designed for the delineation and the characterisation of water bodies. The MS_CD is the primary key for all water bodies.

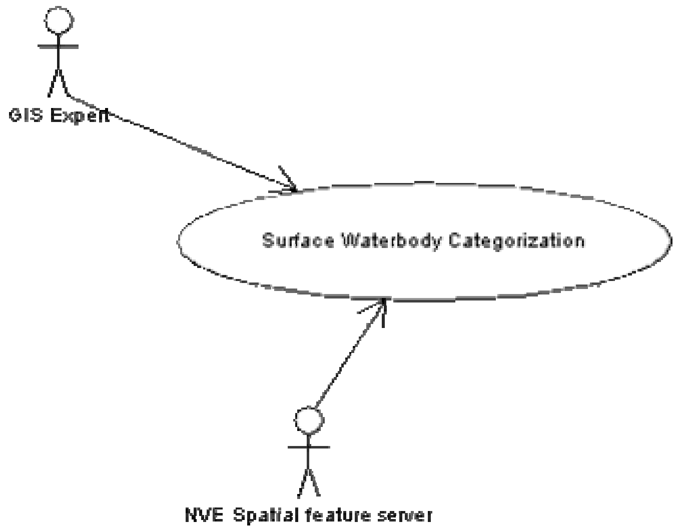
To assign a unique segment code to each river segment in the vector layer, an algorithm developed for the purpose is applied. The code assigned is composed of the three digit River Basin code, a six digit serial number (e.g. 001000034). The MS_CD for river water bodies is created automatically by the WFD management tool used to delineate water bodies and to give them attributes according to characterisation requirements in WFD Article 5. This code is composed of the three digit River Basin code, a digit running from 1 and upwards plus R for river (e.g. 001-1-R). When a water body is divided a new code is created by the WFD management tool. The operator does not have to assign codes at all. River segments running through lakes smaller than 0.5 km² are included in the river water body selection and have the same MS_CD as the rivers. In this way the smaller lakes get included in a water body. River segments running through lakes designated as lake water bodies are assigned the MS_CD for the lake.

All lakes from the size of 0.0025 km² (242 000) are assigned a national lake code (unintelligent serial number). This code is delivered and maintained by NVE and integrated as an attribute in the national water theme layer administered by Statens Kartverk, the Norwegian Mapping Authority, and used by all actors within water management in Norway. The lake water body polygon layer is a copy of this layer with columns added for WFD data. All 242 000 lakes is assigned a 'theoretical' MS_CD in the attribute table composed of the three digit River Basin code, the lake serial number and L for lake (e.g. 001-2345-L). Only lakes lager than 0.5 km² is assigned in a relational table as a lake water body. This has been done by the operator with the help of selection and calculations in GIS. If the operator wants to add a lake smaller than 0.5 km² as a water body, because of pressure/impact reasons, the system adds the lake in the relational table. When a lake has to be split a new code for the lake water body is created and added to the relational table (e.g. 001-2345-L → 001-2345-1-L and 001-2345-2-L).

The coastal water bodies were first created with a basis in the units used by Norwegian authorities for handling the environmental administration of fjord and coastal areas (the Fjord Catalogue). These areas were coded (Fjord Catalogue ID) according to which sea- and fjord area they belong to. To create water bodies from these polygons a subdivision was made according to water type and pressure/impact. The MS_CD for unsplit Fjord Catalogue polygons is composed of the Fjord Catalogue ID, ten digits, plus C for coast (e.g. 0100102030-C). When one of these polygons is split in two, as separate water bodies, a serial number is added as for the lake polygons (e.g. 0100102030-C → 0100102030-1-C and 0100102030-2-C).

For the reporting of Article 3 and Article 5 the corresponding templates are downloaded from the WISE Internet site to the local server, and then populated by the operator with features and the correct data in each column of the attribute table by importing from the different layers. The populated layers are then uploaded to the JRC server via Water Information System for Europe (WISE). By using this service it is ensured that all codes, names and other requested data are delivered. The uploading to the WISE portal is however not part of RISE.

Surface Waterbody Categorization (Norway)



Use Case Description	
Name	Surface Water Body categorization
Priority	High
Description	Surface water bodies are delineated from layers based on the water theme layers delivered by the mapping agency. A unique national feature code is automatically assigned to the surface water bodies, along with the name of the water body with the help of a WFD management tool designed for the WFD purpose. The national feature code is then expanded to a European code by calculating tools in GIS.
Pre-condition	Surface water layers have to be prepared and made available for the delineation of water bodies in the appropriate scale. Names of surface water bodies are available. A national coding system for surface water bodies is in place. The rules for the European code creation and the attributes requested by the WFD are known.
Flow of Events – Basic Path	
Step 1.	The river network, lake and costal water layers are copied from the national water theme layers in 1:50 000 and prepared as a network for the rivers and as polygon layers for lakes and coastal areas following the WFD specifications, and saved as new layers.
Step 2.	The user adds new columns for the unique national water body code, EU code and name, according to the WFD requirements to the layer attribute tables.
Step 3.	The user selects one or more river segments in the river network layer as a water body, based on water type and pressure. The user then runs the WFD management tool developed in order to update the attribute table with the water body code and river name for the selected segment (s).

Use Case Description	
Step 4.	The user employs the WFD management tool to add water type and impact/pressure to relational tables where all information are linked to the river water body feature via the MS_CD
Step 5.	In the lake layer, lakes larger than 0.0025 km² are given a unique MS_CD through running a routine. The code is stored in the lake water body feature table. The user then exports all lakes larger than 0.5 km² to an additional relational table.
Step 6.	The user performs the lake water body characterisation by using the WFD management tool and adds information about water type and impact/pressure to relational tables coupled to the features via the MS_CD. If a lake smaller than 0.5 km² is 'at risk' the management tool asks the operator if it should be created as a new water body. If yes, it is added automatically in the relational table. Names from the original dataset, catchment codes etc. are stored in the feature table for all lakes larger than 0.0025 km².
Step 7.	The user selects the coastal water body layer by using the map interface in the Norwegian WFD management tool and assigns a MS_CD to the features according to the division of the coastal water theme into administrative units done by the Directorate for Nature Management.
Step 8.	The user uses the WFD management tool to further subdivide the suggested coastal water bodies into smaller units, based on water type and impact/pressure. The management tool generates a new code for the divided water body and adds this to the MS_CD column in the feature table. The water body category, impact/pressure etc. are added automatically to relational tables via the MS_CD.
Step 9.	For all categories of surface water bodies the EU_CD is manually calculated by adding the national prefix to the MS_CD when needed.
Step 10.	For all categories the user enters the status year and category information into relational tables by running the WFD management tool.
Flow of Events – Alternative Paths	
Step 3a.	Rivers running to and from Sweden and Finland have to be connected to the Norwegian river network and vice versa to be able to delineate complete river water bodies within common catchments and to run correct hydrological analysis needed for the assessment of impact/pressure. The networking topology needs to be run again
Step 3b.	A common water body code has to be agreed on for the river water bodies where its water course or catchment is split by the national border.
Step 5a.	Lakes split by national borders might become large enough to be reported due to their size when merged. Lakes larger than 0.5 km² are to be reported as a water body according to the directive. Lakes that are smaller than 0.5 km² on the Norwegian side may be due for reporting when the Swedish/Finnish half is added with the feature coding to be discussed. Border lake water bodies smaller than 1.0 km² are defined as a water body on the Norwegian side, but not on the Swedish/Finnish side.
Step 5b.	A common code has to be agreed on for lakes split by the national border.
Step 8.	Names for coastal water bodies have to be added manually each time by operator with the help of the management tool.
Post-condition	Each surface water bodies is categorized according to River Waters, Lake Waters and Coastal Waters according to the WFD Guidelines, carries a unique national code and the attributes required by the WFD. The file names follow the convention proposed by the WFD.

Use Case Description	
Data source: Statens Kartverks national water theme layers	
Description	The National water theme layers are a compilation of coastal and inland waters in Norway.
Data provider	Statens Kartverk (Norwegian Mapping Agency)
Geographic scope	Norway
Thematic scope	Surface Water bodies: Rivers, Lakes, Canals etc. and Coastal waters
Scale, resolution	1:5000 and 1: 50 000
Delivery	Delivered in SOSI interchange format, other formats on request.
Documentation	http://www.statkart.no/standard/sosi/html/div/hoeringsdokumenter/hoeringsdokument_site.htm (in Norwegian)

5. Landcover Use Case Scenario

5.1 The landcover scenario in Sweden

5.1.1 Introduction

The landcover data processing in Sweden has been tasked to and laid out by the Swedish Agricultural University, partner of the SMED consortium tasked with the WFD report assembly in Sweden, upon request by Swedish Meteorological and Hydrological Institute (SMHI).

5.1.2 Landcover input data processing

The following section details the processing of landcover information towards the relevant input parameters for the N and P modelling in the Diffuse Nutrient leakage context of the WFD carried out by Sweden. The specific landcover classes created in the processing and considered hereunder are thereby those required by the Swedish TRK diffuse nutrient leakage model for P and N [13],[15]. This model has, other than for the WFD reporting, been employed for the regular Pollution Load Compilation (PLC) to the Helsinki Commission (HELCOM) of the Baltic States.

The landcover information for the model is processed in order to calculate the leaching of N and P from different landcover types, with a focus on agriculture. Reference areas for the model are catchment aggregations, the so-called TRK areas. There are about 1000 TRK areas in Sweden, which have been obtained through manually aggregating primary catchments to TRK catchments of varying size (ca. 200-450 km^2 in the South, ca. 400-700 km^2 in the North of Sweden).

Two basic landcover parameters the Swedish model involves as input parameters are:

- the sum of landcover classes obtained per TRK catchment area
- the actual area of each crop per (agricultural field) block in each catchment

In the present use case, the resulting parameters from the landcover data processing are stored in separate ASCII tables as per TRK area. The parameter tables are then eventually read into the numerical N and P leakage model for further calculation.

The Scenario:

The Swedish TRK model requires for the N and P leakage calculation information on a defined set of landcover classes. These are:

- Urban areas,
- Forest,
- Glacier,
- Mountainous area above the treeline,
- Wetlands,
- Water (rivers and lakes),
- Forest clearcut areas,
- agricultural areas,
- National Sea,
- International Sea.

The request for this landcover input data is received by the consortium partner in charge of providing that information via email/telephone call from the party performing the TRK modelling. Upon receipt of that request the GIS specialist logs on to the consortium's ftp server and downloads the TRK catchment vector file provided onto a local machine.

For the production of landcover information needed for the nutrient leakage modelling, various sources of information are employed. The basis is the coverage of the Swedish general map holding landcover information at scale 1: 250 000. It is copied from the CD on which it was provided onto the local workspace and converted to a 25 x 25 m raster saved under a temporary name. The raster format is chosen due to the data volume processed.

Two landcover classes need to be added to the existing classes present in that map, namely 'Agricultural land' and 'Forest clear cuts'. In order to determine the location and extent of these areas the class 'Open Land' is refined indicating 'agricultural areas', and 'Forest' with 'Clear cuts' employing additional data sources.

For the agricultural land determination, the so-called 'Block database' vector (shape) file is copied from the CD on which it was delivered onto the local disk and visualized. Each block represented in that file has polygon geometry and an ID. The ID can be linked to a database file holding information on areas of crops within the block polygon. The Block data is rasterized to a pixel size of 25 x 25 m using the same extent and projection as the landcover grid. The Block ID is an 11 digit integer number. To be able to handle the rasterized block data in the Raster handling module of the software employed, the ID has to be remapped to numbers lower then the Integer maximum size by applying a lookup table.

A second data source for the refinement of the landcover map is data on forest clear cuts. The map comes as a polygon file and is rasterized to 25 x 25 meter pixel size as well.

To determine the landcover for the catchment area parts lying outside of the Swedish territory, the Baltic Drainage Basin Land cover data from UNEP/GRID is opened by the GIS expert on the local computer and re-sampled with the nearest neighbour option to a pixel size of 25 x 25 meters. Also, since the 'Open Land' class is considered for landcover information refinement in the process, open land areas in the GRID dataset West of 1765000 and north of 6750000 (Swedish reference System) are reclassified as 'Mountainous'.

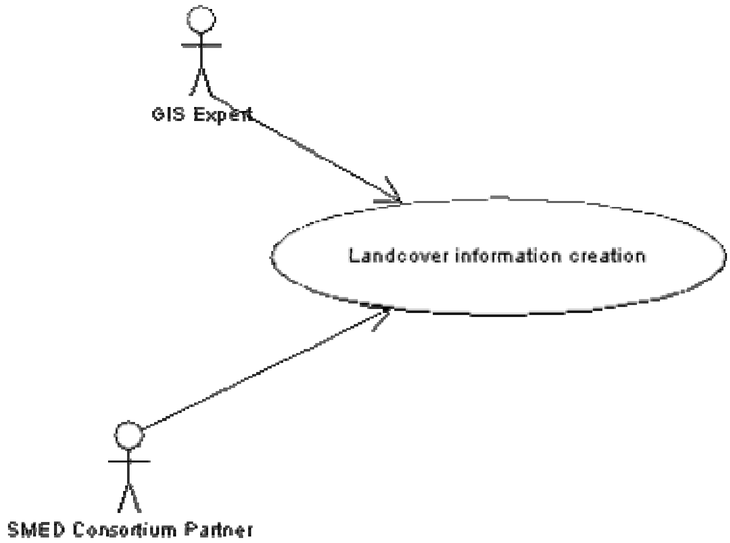
After having treated these data sources, the GIS expert proceeds to overlaying the Block data and the clearcut raster data onto the GRID landcover and general map landcover raster data. With a routine, those pixels in the General map overlapped by the block data raster and/or the clearcut raster, are reclassified into the 'Agricultural land' and 'Clearcut' classes respectively. Agricultural land as determined by the block data polygons takes precedence over the clearcut areas where they overlap. The Forest clear cuts have the second highest priority and the initial landcovermap the lowest.

The GIS expert then calculates the sum of the landcover classes obtained per TRK area. The total area of each landcover class in km^2 in each catchment is obtained through applying the polygon coverage of the catchment areas as a cookie cutter for the landcover raster created in the previous step. The corresponding attribute table is then saved and exported to ASCII format.

The same procedure is applied to the rasterized agricultural block data in order to calculate the area of each block (as determined by its remapped ID) per each TRK catchment. The resulting table is fed into a local database with a temporary name. Using the statistics from the cookie-cut operation and the crop area table, the area of each crop is calculated for each catchment using a SQL procedure. As there are blocks with no corresponding crop area information, as well as crop area IDs which do not match with a block polygon, the table calculation is carried out as percentage of a block area.

The GIS expert then accesses the consortium's ftp site and uploads the ASCII files produced from his/her machine. The consortium partner proceeding with the numerical pollution modelling is informed via email upon completion of the upload.

Landcover information creation (Sweden)



Use Case Description	
Name	Landcover information creation
Priority	High
Description	The type and size of landcover present within a TRK catchment is determined.
Pre-condition	Landcover and catchment data is available, required landcover information is specified.
Flow of Events – Basic Path	
Step 1.	Upon receipt of a request for landcover data for the nutrient leakage modelling, the user downloads the TRK catchment data from the consortium's ftp server.
Step 2.	User copies landcover map (scale 1: 250 000) onto local disk, opens the vector coverage and rasterizes it.
Step 3.	User loads the landcover data corresponding to catchment area parts lying outside of Sweden and resamples it to 25x25 m pixel size.
Step 4.	User copies the Forest clearcut map on the local disk and rasterizes the map.
Step 5.	User loads and rasterizes the Block database.
Step 6.	User overwrites pixel values in the basemap and the GRID map based on pixel values of block data and clear cuts.
Step 7.	User merges the GRID and landcover basemap and saves the result.
Step 8.	User overlays landcover raster with catchment polygon and performs cookie cutter operation based on TRK catchment areas
Step 9.	User calculates size of each landcover class within each catchment
Step 10.	User overlays Block database raster with catchment polygon and performs cookie cutter operation based on TRK catchment areas.
Step 11.	User calculates size of each Block within each catchment.
Step 12.	User loads the results from Blocksize calculation as per catchment into local database table.
Step 13.	User loads ASCII table with crop information into a local database table.

Step 14.	User calculates crop areas for each catchment using the tables from Step 12 and 13.
Step 15.	User saves resulting attribute tables and exports them to ASCII format.
Step 16.	User uploads ASCII file to the consortium ftp server.
Flow of Events – Alternative Paths	
Step 7.	Merged rasters do not match.
Post-condition	Landcover percentage distribution per catchment is available in ASCII table format for input into the numerical modelling as well as crop area per Block.
Data source: Blockdatabase	
Description	The Block database captures the agricultural fields (aggregated in Blocks). Each block carries a fixed ID, continuous reporting leads to yearly update of the block area.
Data provider	Swedish Agricultural Board
Geographic scope	Arable land areas
Thematic scope	Monitoring of crops grown on agricultural fields.
Scale, resolution	1:10 000
Delivery	.shp file, on CD
Documentation	Swedish Agricultural Board
Data source: IAKS cropdata	
Description	The IAKS cropdata is an attribute table corresponding to the the Block database units. It captures the crops grown on the agricultural fields (aggregated in Blocks) as reported by the farmers. Each block carries a fixed ID and as further attributes the IAKS Crop code, Crop name, crop description and crop area. There are around 80 classes in the IAKS cropdatabase which can be aggregated to the following croptypes: Spring Barley, Winter Barley Spring rape Potatoes Pasture Minor crops Undefined arable land Winter wheat Ley Sugar beets Winter rape Green fallow Oats Spring wheat Winter rye Continuous reporting leads to yearly update of the attributes per block. Thematic rules on mixed cropping exist.
Data provider	Swedish Agricultural Board
Geographic scope	Arable land areas
Thematic scope	Monitoring of crops grown on agricultural fields.
Scale, resolution	1:10 000, originally derived from cadastre data.
Delivery	.shp file, on CD

Documentation	Swedish Agricultural Board
Data source: TRK catchment (TRK area) map	
Description	The TRK area map
Data provider	SMHI
Geographic scope	Sweden
Thematic scope	Aggregation of catchment areas for TRK model input
Scale, resolution	1: 50 000
Delivery	.shp file
Documentation	http://www-nrciws.slu.se/TRK
Data source: General Map	
Description	Overview map on Administrative division, Hydrography, Land cover and land use, Communication lines, Built-up areas, Contours, Areas with regulated or restricted use. Areas can be of type sea, lake, built-up areas, other concentrated building development, forest, open land, alvar, mountain area above the treeline, glaciers and marshland.
Data provider	Lantmäteriet
Geographic scope	Sweden
Thematic scope	Used for landcover depiction.
Scale, resolution	1. 250 000
Delivery	Vector file, on CD
Documentation	General Description of GSD-the General Map, version 3.0, 09-09-2004
Data source: Clearcut areas	
Description	Location of clear cuts is available, with changes detected on a yearly basis.
Data provider	Swedish Forestry Board
Geographic scope	Sweden
Thematic scope	Clearcut monitoring
Scale, resolution	1:250 000
Delivery	.shp file on CD
Documentation	N/A
Data source: UNEP GRID-Arendal Baltic Sea Region GIS Landcover	
Description	The Land Cover data layer of the Baltic Sea Region GIS consists of six classes: Forest, Open Land, Open Water, Urban Land, Glacier, and Unknown Land, which is either Forest or Open Land.
Data provider	UNEP-GRID Arendal
Geographic scope	Baltic Sea region
Thematic scope	Land cover
Scale, resolution	~ 1:1 000 000, pixel size 1 x 1 km finest resolution available
Delivery	Originally downloaded from the Internet, area downloaded defined through box
Documentation	http://www.grida.no/baltic/htmls/intro.htm

5.2 The landcover scenario in Norway

5.2.1 Introduction

The landcover data processing for Diffuse Nutrient Leakage modelling is carried out by the Norwegian Institute for Agricultural and Environmental Research (Bioforsk) and the Norwegian Institute of Land Inventory and the Norwegian Institute for Water Research.

5.2.3 Landcover input data processing

The following section details the processing of landcover information towards the relevant input parameters for the N and P modelling within the Diffuse Nutrient Leakage context of the WFD reporting in Norway.

The calculation of N and P from land based sources is carried out using the TEOTIL2 model. The model's original purpose in the preceding 'TEOTIL' version was to obtain nutrient losses (N and P) in connection with the development of a plan for the North Sea Area to be able to achieve the goal of 50% reduction in the nutrient leakage discharge into the North Sea in the OSPAR area. For this original purpose, the model also includes point sources from land use and the contribution from aquaculture. For the WFD reporting purpose, the latter is not included and in the scenario for the RISE context only the method for diffuse sources is considered.

The calculation of Diffuse Nutrient leakage in TEOTIL2 from agricultural areas is based on the area information from the landcover and on the coefficients resulting from two empirical models run by the Norwegian Institute for Agriculture and Environmental Research and the Surveillance Programme on Soil and Water in Aquaculture (JOVA) with adjustments for changes in cultivation pattern.

For the other landcover classes in TEOTIL2 (forest, outlaying fields, mountains, lakes), the background runoff is calculated by employing a runoff coefficient based on the surveillance data for water bodies without substantial human pressure, provided by the Norwegian Institute for Water Research (NIVA), and the land cover area classes.

The two basic landcover parameters involved as input parameters for the modelling are thus:

- the sum of landcover classes obtained per catchment
- the diffuse nutrient leakage coefficient calculated for each land use class

The TEOTIL2 so far does not employ any GIS processing. In the present use case scenario, the N and P are calculated per river basin with the help of GIS, opening a new approach through involving spatial data captured for the extraction of model input parameters. Basis for the Landcover parameters involved is the Landcover classification as in TEOTIL2, which is modified towards the WFD reporting context for N and P leakage. Statistical units based on catchment areas are used, the result of these calculation then aggregated per river basin.

The Scenario:

The layer used for the calculation of diffuse nutrient leakage for N and P is put together from a set of grid data from the Norwegian mapping agency, Statens Kartverk (SK) and the Norwegian Institute of Land Inventory (NIJOS) in the following way:

The SK delivers a 25 m grid data set (N50_Areal25) where the main land use classes are defined. The landcover classes given there do not fully comply with the ones needed for the parameter extraction for the N and P model calculations.

Actual landcover classes required for the WFD context are:

- Covered Surfaces,
- Arable Land,
- Meadows,
- Outlying Fields,
- Forest,
- OtherLandcoverClasses
- Inland Waters.

The first step in the process is to group all superfluous classes in the N50_Areal25 grid by the GIS expert. The resulting grid, called NewArea, is then used in the further process.

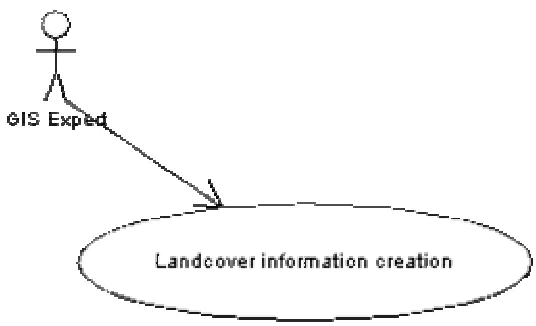
The 'Mountain areas' are added to the NewArea grid, as that class is not defined in N50_Areal25. This is done by using a grid where the cells above the forest line (the maximum altitude for forest) are coded for mountain and those below as 0. The result is merged with the NewArea grid where 'empty" cells are coded as 'NoData' to produce a new grid, NewArea2

The GIS expert proceeds to rasterizing the lake and river polygon layers to grids with a 25 x 25 m pixel size respectively. These grids are consecutively merged to the resulting grid, InlandWaters, consisting of broad rivers and lakes are then applied in a new merge with the NewArea2 where the inland waters are merged into a new grid NewArea3. The values for 'empty' cells in the NewArea2 grid carry the 'NoData' label before merging them with the 'InlandWaters' class.

A grid containing the classes needed for the nutrient leakage results, with the classes 'Meadows', 'Outlaying fields' and 'No or sparse vegetation' (= areas below the forest line) still to be delineated. The Landcover map delivered by NIJOS has got classes for different land use where forest and agricultural land are divided into productivity classes. The classes needed from this grid are those missing in the NewArea3 grid created in a previous step. The landcover grid is converted to a polygon layer where all polygons except for 'Meadows', 'Outlying fields' and areas with 'No or sparse vegetation' are deleted. The polygon layer is then converted to a new grid by the GIS expert, where the cells with missing data have got 'NoData' value. That grid is then merged with NewArea3 to produce the grid NewClasses.

The NewClasses grid contains all classes needed for the diffuse nutrient leakage calculation. It is converted to a polygon layer to be able to determine the area size of each class. The N and P leakage in the successive calculations is then determined as per river basin or per primary catchment by combining the class area size and diffuse nutrient coefficient for each landcover class.

Landcover information creation (Norway)



Use Case Description	
Name	Landcover information creation
Priority	High
Description	The type and size of land cover classes within a river basin
Pre-condition	Land cover in 25x25 m and catchment data is available, required land cover class information is specified.
Flow of Events – Basic Path	
Step 1.	The user groups the original classes in the N50_Areal25 grid from SK into the classes required for the nutrient leakage calculation. The result is a new grid, NewArea.
Step 2.	The NewArea grid has got NoData for areas above the forest line. To fill in values for the mountain cells the grid containing cells with value above the forest line is merged with NewArea to the grid NewArea2.
Step 3.	The NewArea2 grid has got 'NoData' for the cells for water. Therefore a raster (25x25m pixelsize) has to be made from the layer with lakes and the one with river polygons. These two layers are then merged by the user to form one grid which is called InlandWaters.
Step 4.	The InlandWaters grid is merged with NewArea2 to fill the cells for the class 'Water' with a value. The result is a new grid, NewArea3.
Step 5.	The Landcover map DMKFREG grid from NIJOS contains 'subclasses' for forest and agricultural land in addition to the classes missing in NewArea3. The grid is converted to a polygon layer to be able to extract the three landcover classes not described in N50_Areal25.
Step 6.	The user deletes all superfluous classes in the DMKFREG polygon layer. The layer is converted to grid where cells without information are given value 'NoData'.
Step 7.	The new DMKFREG grid is merged with NewArea3 to produce the NewClasses grid, which contains all classes needed for the calculation of diffuse nutrient leakage.
Step 8.	The NewClasses grid is converted to a NewClasses polygon layer by the user in order to obtain the total are for each class.
Step 9.	The total are for each class is calculated with the diffuse nutrient leakage coefficient for N and P.
Step 10.	The results merged for the river basin districts, saved in an appropriate format and reported to WISE.
Flow of Events – Alternative Paths	
Post-condition	Land cover class percentage distribution per river basin (or any catchment size) is available by applying a GIS overlay involving the NewClasses polygon layer and the catchment layer.
Data source: N50_Areal25	
Description	The N50_Areal25 provides a 25x25 grid of Norway divided into the main land use classes.
Data provider	Statens Kartverk (Norwegian Mapping Agency)
Geographic scope	Land cover classes
Thematic scope	Landcover classes
Scale, resolution	1:50 000
Delivery	Grid, on CD
Documentation	Statens Kartverk (Norwegian Mapping Agency)
Data source: Statens Kartverks national water theme layers	
Description	The National water theme layers are a compilation of coastal and inland waters in Norway.

Data provider	Statens Kartverk (Norwegian Mapping Agency)
Geographic scope	Norway
Thematic scope	Surface Water bodies: Rivers, Lakes, Canals etc. and Coastal waters
Scale, resolution	1:5000 and 1: 50 000
Delivery	Delivered in SOSI interchange format, other formats on request.
Documentation	http://www.statkart.no/standard/sosi/html/div/hoeringsdokumenter/hoeringsdokument_site.htm (in Norwegian)
Data source: Area above forest line	
Description	The areas above the forest line are derived from using the DEM in combination with the maximum height of the forest growth.
Data provider	Statens Kartverk (Norwegian Mapping Agency)
Geographic scope	Mountain areas of Norway
Thematic scope	Identifying mountain areas
Scale, resolution	1000x1000 m grid
Delivery	grid
Documentation	NVE
Data source: DEM	
Description	Digital elevation map with 25x25 m cells.
Data provider	Statens Kartverk (Norwegian Mapping Agency)
Geographic scope	Norway
Thematic scope	Used for analysis purposes
Scale, resolution	25x25 grid
Delivery	grid, on CD
Documentation	Statens Kartverk (Norwegian Mapping Agency)
Data source: DMKFREG	
Description	The DMK_FREG grid is a simplified land use map of Norway and contains information on soil quality.
Data provider	NIJOS
Geographic scope	Norway (not complete yet)
Thematic scope	Information on landcover productivity classes
Scale, resolution	1: 50 000
Delivery	grid on CD
Documentation	NIJOS

6. Elevation Use Case Scenario

6.1 The elevation scenario in France

6.1.1 Introduction

In France, the Bureau des Recherches Géologiques et Minères (BRGM) has contributed to the WFD reporting, contracted by the French River Basin managers (Agence de l'Eau). The WFD report France has submitted to the EC refers to the six River Basin districts present. For the WFD reporting, BRGM has provided the calculation of the Indice Développement Persistence des Réseaux (IDPR) for the catchment areas.

The IDPR index indicates the following:
In the event of a perfectly homogeneous environment with zero permeability, only slope and landscape morphology will influence the drainage of water. The search for so-called thalwegs (i.e. the lines of greatest slope), which collect the runoff waters through gravity, should thus lead to a reproduction of the drainage network. In reality, the natural drainage network differs from that theoretical network, and it is the difference between the two that reflects the environmental complexity.

The idea underlying the IDPR therefore derives from the premise that as

a) the structure of the drainage network, the thalwegs, depends on the natural ground relief, and
b) the structure of the drainage pattern depends on the underlying geological context,
c) the difference between the thalweg network and the drainage pattern reflects the influence of the subsurface environment.

The IDPR becomes thus a means of indirectly quantifying the transfer function for water from the surface to the subsurface. It compares a theoretical drainage network established according to the hypothesis of a perfectly homogeneous environment (the Development Index – ID) against the natural network formed under the control of a heterogeneous geological context (the Network Persistence – PR). The index takes into account the role of the subsurface environment in the formation of the drainage network and can hence be used for an indirect approach to the inherent nature of the ground regarding surface-water infiltration or runoff. The IDPR varies from 0 to n and is then normalised between 0 and 2, whereby

- IDPR < 1: The infiltration is greater than surface runoff. The runoff water on natural ground joins a drainage axis defined by a thalweg analysis without this being obvious through the presence of a natural hydrological axis.
- IDPR = 1: Infiltration and surface runoff are equal. There is conformity between the availability of drainage axes associated with the thalweg and in situ flow.
- IDPR > 1: Surface runoff greater than infiltration to the subsurface. The runoff water on natural ground very rapidly joins a natural hydrological axis whose presence is directly justified by a thalweg. An IDPR close to or equal to 2 reflects a temporary or permanent stagnation of the water, leading to two different interpretations: if the water table is close to the natural surface, (water course and wetlands), the ground is saturated and the water no longer infiltrates; if the water table is deep, the runoff character may indicate an imperviousness of the natural ground. It is suggested that IDPR values greater than 2 are mainly assignable to wetland.

6.1.2 Elevation input data processing

This chapter describes the scenario of the elevation input data processing from a DEM for the IDPR calculation in the WFD context of vulnerability mapping. The IDPR thereby is based on the French Terrain reference data provided by the Institut Géographique National (IGN).

The Scenario:

For the IDPR analysis, two data sources are used: Elevation data stem for the calculation of the theoretical drainage network based on a DEM (50 x 50 m); for the extraction of the real drainage network, hydrography data is used. The result of IDPR calculation is a grid with the size and extent of the input DEM.

For the calculation of the theoretical network, the GIS expert transforms the DEM tiles from the .ASC format in which they are stored on the local server into .GRD format and georeferences them. The CRS used is: datum NTF – projection Lambert II étendu; the georeferencing is done automatically when integrating the DEM on Arc View. Then, all tiles are mosaiced into a single file.

The actual processing of the DEM for the IDPR calculation consists of detecting and filling depressions in the terrain grid so that the water flow can be routed. A depression thereby is a cell with an undefined drainage direction as no cells surrounding it are lying lower. The principle in processing is to suppose that a hole is filled with water before the water continues its course. Therefore, with an automated routine, each hole's outlet point is detected in the DEM, then the holes are filled.

With that processed DEM, the GIS expert proceeds to the calculation of flow direction and accumulation. The direction of flow is determined by finding the direction of steepest descent from each cell. This is calculated as the difference in altitude between two points divided by the distance between these points. The consecutive Accumulation grid calculation shows how much area 'flows' through each grid cell. Output cells with a flow accumulation of zero thereby are local topographic highs and may be used to identify ridges.

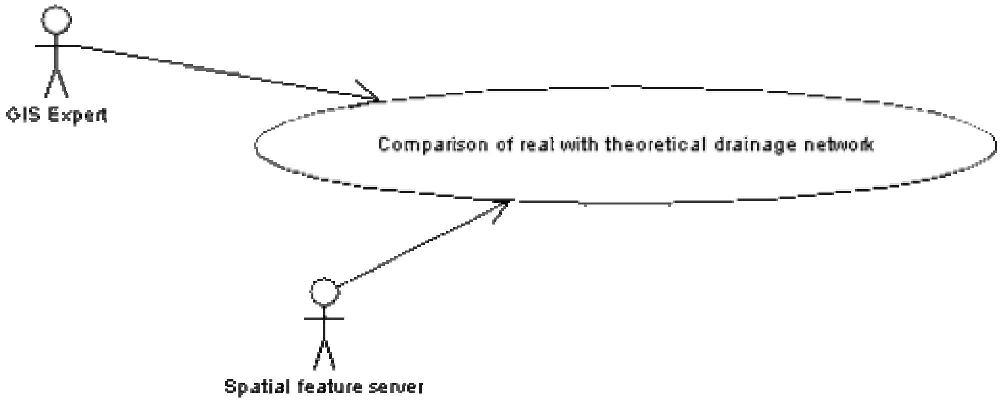
To establish the so-called Drainage-Grid-Distance from the above results of flow direction and accumulation calculation, a tool to define the stream delineation grid is run. It calculates a grid of distances from one stream to another.

The GIS expert then proceeds to the comparison of that theoretical drainage network with the real hydrography. In order to do so, the rivers network vector file is loaded from the server. The file is opened, and the grid of Eucledian distance of each river's arc to the other (the so-called River-Grid-Distance) is computed. Extent and pixelsize of the grid are equal to the grid created for the Drainage-Grid-Distance.

The IDPR is then determined as per catchment area as ratio value between the River-Grid-Distance and the Drainage-Grid-Distance.

The resulting parameter grid holding the index values is consecutively used for the vulnerability mapping in the WFD reporting context.

Comparison of real with theoretical drainage network



Use Case Description	
Name	Comparison of real with theoretical drainage network
Priority	High
Description	The real drainage network is compared with the theoretical drainage network in order to estimate surface-water infiltration or runoff in a drainage network. The comparison is expressed through an index, the IDPR. The theoretical network is deducted from elevation data (a DEM) which needs to be processed as input parameter for the IDPR calculation.
Pre-condition	Elevation data requirements are known. Natural network river and model elevation data is available.
Flow of Events – Basic Path	
Step 1.	The user loads the tiles of the digital elevation model data from the local server, converts them from .ASC into .GRD format and georeferences them.
Step 2.	Tiles are mosaiced into a single file; possible errors occurring at tile edges have to be corrected.
Step 3.	The user calculates a filled DEM. This operation identifies depressions and 'fills' them so that flow can be routed to compute the watershed boundary. The calculation takes place through an automated algorithm.
Step 4.	Based on the filled DEM, flow direction and accumulation are calculated.
Step 5.	User runs a tool to define the stream delineation grid after be prompted to define a threshold for an area to be called a stream.
Step 6.	User calculate a grid of distance from each stream to the next (Drainage-Grid-Distance)
Step 7.	The user loads the natural rivers network shape file from the server, opens the file and calculates a grid of distance of each river's arc to the others (River-Grid-Distance)
Step 8.	The user selects the catchments with a minimum size for the index calculation from the hydrography data.
Step 9.	User calculates the ratio value between the River-Grid-Distance and the Drainage-Grid-Distance as per catchment.
Flow of Events – Alternative Paths	
Post-condition	The index of comparing the real with the theoretical drainage network is available as a GRID.

Data source: Terrain Reference Database for France BD_Alti	
Description	BD ALTI® is a relief reference system that covers France and describes the shape of the terrain at different scales (from 1:50 000 to 1:1 000 000). It consists of contour lines and points quoted by digitizing maps and photogrammetric restitution of aerial photos. For the IDPR calculation, the 50 x 50 m grid (1: 50 000) is used.
Data provider	IGN
Geographic scope	France
Thematic scope	Elevation data
Scale, resolution	From 1:50 000 to 1:1 000 000, 50x50 m grid
Delivery	DIS, GRID, Arc/Info, XYZ ASCII on CD
Documentation	http://www.ign.fr/rubrique.asp?rbr_id=1622 (in French)
Data source: River network map from BD CARTHAGE	
Description	BD CARTHAGE is produced using the hydrography layer of BD CARTO® (by IGN) enhanced by the MEDD (Ministry of Ecology and sustained development) and Water agencies with territorial breakdown into hydrographical zones and codification of these zones and the hydrographical network.
Data provider	IGN
Geographic scope	France
Thematic scope	Hydrography dataset
Scale, resolution	1: 50 000
Delivery	ARC/INFO export, shapefile, MIF/MID, GeoConcept on CD
Documentation	http://www.eaufrance.fr/ http://www.ign.fr/rubrique.asp?rbr_id=1960 (in French)
Data source: SRTM Digital Elevation Data	
Description	SRTM 90m Digital Elevation Data
Data provider	CGIAR-CSI SRTM
Geographic scope	World
Thematic scope	Elevation data
Scale, resolution	90x90 m grid
Delivery	Download from http://csi.cgiar.org/
Documentation	http://srtm.csi.cgiar.org/

7. The RISE Data Harmonisation Components in SDIGER

The SDIGER project presents a Spatial Data Infrastructure (SDI) to support access to geographic information resources related to the Water Framework Directive (WFD). One of the two use cases of the project deals with the use of INSPIRE principles for fulfilling WFD article 5 requirements for the 2005 reporting by Member States. The scenarios have been developed for two adjoining River Basin Districts along the French/Spanish border, namely the Adour-Garonne (France) and the Ebro (Spain) River Basin District [11].

The SDIGER idea to make existing data, which were more or less already WFD compliant, accessible for reporting, was facilitated through a web application developed. It offers the users of the Competent Authorities in the River Basin Districts the possibility to choose a report sheet, display the geographic features in a defined geographic extent and produce maps showing the different geographical features that have to be reported as stated by article 5 of the WFD.

SDIGER has not specifically addressed harmonisation issues as such. The project offers however the opportunity to analyse another type of a WFD reporting use case developed with regard to the RISE methodology and its data harmonisation components, assuming potential harmonisation issues due to its cross-sectoral and crossborder nature. Consequently, the RISE checklist structure was used for analysis of the question in how far SDIGER relates to the RISE methodology. Also, the actual harmonisation approaches are indicated as well in the checklist. SDIGER proved to be useful in the RISE context, as it provides examples of different practices in France and Spain, and gathers experience with respect to data harmonisation components like the definition of a common model, multi-lingual aspects, data translation etc. Furthermore, the use of the checklist structure for the SDIGER examination has helped to continuously refine the checklist established by RISE. The result of the SDIGER analysis can be found in the Annex.

8. Conclusion

In the present document, the RISE Use Case Template and Checklist Template with information referenced therein are used to analyse the Swedish, Norwegian and French scenarios regarding hydrography, landcover and elevation input data processing respectively in the context of WFD reporting on Diffuse Nutrient leakage. The analysis depicts the actors, data(models) and the workflows involved and enables the identification of cross-sector and cross-border harmonisation needs towards the three different thematic data products in the WFD reporting context selected by RISE.

The RISE Methodology recommends taking the information provided by the detailed use case descriptions for the development of the Conceptual Schema in UML, the GML Application Schema and the corresponding Data Product Specification. The RISE Use Case Document and the Checklist for the input data processing for Diffuse Nutrient leakage modelling have provided adequate information to assist in the modelling towards these harmonised Data Product Specifications. This holds true for those scenarios where the approach taken by the various countries can be illustrated and examined in the light of the specific user requirements posed by the application in question and the data sources used.

The RISE Methodology assumes that user requirements for an application can be identified and documented, and that input data sources can be examined with respect to the various aspects described in the data harmonisation components, which also form the basis for the Checklist. It was observed though, that not all data harmonisation components could be investigated easily, as the required information was not always available. That applies to both, the actual user requirements of the application as well as the 'as is' situation of the thematic input data used by the actors in the various scenarios. These circumstances presented a challenge in establishing the harmonised Data Product Specifications using the RISE approach. In practice, projections in the schema development and reiterative feedback from these processes into the Use Case analysis have taken place for those scenarios where the user requirements were lacking.

It should be noted therefore that even though the RISE Methodology provides a framework for developing harmonised Data Product Specifications, developing such specifications in practice remains a complex task, and requires significant resources and a high degree of expertise as applications often do not (yet) spell out their user requirements regarding source data. Likewise, the Checklist Template is a very comprehensive one which anticipates the thorough characterisation of the various harmonisations components of input data sources. However, the experience shows that a lot of available data is not documented properly.

The RISE approach for the development of harmonised data product specifications is designed around a spiral engineering approach and driven by the availability of relevant information. With the help of the user requirements obtained, a first harmonised spatial data product has been developed following the RISE Methodology within the project scope. Ideally, a reiteration of this first spiral development loop should be carried out, which is expected to lead to a refined harmonised data product specification for the application of the nutrient leakage modelling in question available to the user community. This iteration would consider the experiences gathered so far, require the availability of a more thoroughly defined set of requirements and appropriately documented data, and possibly draw from a broader base of countries involved in the reporting. As a result, with the input from the progressed Use case analysis and extended and enrichened information from the Checklist, the product specification would be refined with each iteration, increasingly addressing the identified user requirements.

Annex – Completed Checklists

In the Annex, the RISE checklists are attached in MS EXCEL files. The sheets of the attached file comprise of:

- Checklist Overview (from RISE Methodology and Guidelines Document V 1.1 Annex A)
- Checklist-template of harmonisation components and related questions (from RISE Methodology and Guidelines Document V 1.1 Annex A)
- Checklist Hydrography data Sweden
- Checklist Hydrography data Norway
- Checklist Landcover data Sweden
- Checklist Landcover data Norway
- Checklist DEM data France
- Checklist applied to SDIGER