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Report on the Operation of the RISE Testing System

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V0.4	WC	31st Oct. 2007	Additional tests inserted, including Google Earth Link and Thalweg analysis.

Executive Summary

A major objective for the RISE Project was to not only produce a Methodology and Guidelines document, but also to test the procedures for a number of Use Cases, and to test the Application Schema associated with the harmonised Data Product Specification. In order to test the Application Schema, the Project has developed the RISE Test Environment (RTE). This is an on-line web-based resource to facilitate the access to example harmonised Data Products, and to facilitate the display and testing of these products.

The tests need to cover the themes of hydrography, land cover and elevation; and the RISE Use case analysis was used to derive specific test requirements for:

- River-Basin District overview information.
- Surface Water Body Categorisation.
- Land cover information creation for Diffuse Nutrient Leakage (DNL) modelling.
- Comparison of real with theoretical drainage network.

Test data for two regions in Scandinavia were obtained from various organisations in Sweden and Norway. The test areas were the Vindån river basin in the East of Sweden and the Enningdalsälven river basin in the west of Sweden and on the border with Norway. The Vindån test area has been used to demonstrate cross-sector interaction and the Enningdalsälven test area allowed additional cross-border issues to be addressed.

The tests have also shown how harmonised Data Products can be generated as required through the use of translating Web Feature Servers (WFS-X); with the data being downloaded and exploited in GIS applications. Web Coverage Servers (WCS) are also able to satisfy many of the harmonisation requirements for Digital Elevation Models (DEMs) including re-sampling and re-projection.

The RTE has been built using a combination of free open-source software and commercial packages. These include the Minnesota Map server (with WMS and WCS), Interactive Instruments' XtraServer (with WMS and WFS), Snowflake Software's Go Publisher (including WFS) and Oracle's database 10G. Databases and data servers have been installed at both QinetiQ in the UK and Interactive Instruments in Germany in order to demonstrate interoperability and differing functionality between the different software solutions.

The range of tests carried out has been able to demonstrate on-the-fly creation of harmonised Data Products from existing datasets without modifying the underlying database. The necessary schema translation is carried out through a combination of creating new "views" of the data in the database and additional mappings in schema translation software.

Overall, the RISE Testing System has shown the viability of schema translation combined with standards-based information servers as a way of creating new Data Products to satisfy relevant harmonisation requirements without re-engineering existing databases.

The RISE Test Environment can be accessed at:

http://www.pinkbox.space.qinetiq.com:8080/rise/welcome.jsp

although a username and password is also required. These can be obtained by sending an email to wcudlip@qinetiq.com.

Table of Contents

1. Scope

This document provides information on the testing activities carried out by RISE in support of the development of the RISE Methodology and Guidelines document [1]. The relevant workpackage description in the RISE Project calls for the "*Development of the operational Testing System (hardware and software) required to test the application schema. This includes the implementation of databases for existing data models, implementing Feature Translation Services, and developing Client Software Tools to aid in the testing process. The test environment will also be suitable for providing facilities to test some of the outputs of the MOTIIVE Project*".

The RISE Project was also required to *"Engage with users and test the Application Schema making use of the Testing System. Engage with Users to refine the Client Software Tools required to assist with testing".*

All these aspects are addressed in the Report.

1.1. Document Overview

Following this introductory Chapter covering the scope, document overview, references and abbreviations, the Report proceeds to describe the Testing System, the main component of which is the RISE Test Environment (RTE), an on-line web-based resource hosted by QinetiQ and containing data and services provided by QinetiQ and Interactive Instruments (participating through OGCE). Links to the MOTIIVE Test Environment and other external information services are also included in the RTE.

A high-level overview of the RTE Design and Test Plan is provided in Chapter 2 with the main detail being provided in a number of Appendices to this Report.

Chapter 3 presents some of the main test results as related to the RISE Use Case Requirements [2] covering hydrography, land cover and elevation issues. Again, further detail and a more formal approach to the test requirements and the test results are given in the Appendices.

Chapter 4 gives a summary and conclusions for the activities.

The appendices provide information on:

A: The RTE Requirements

B: The RTE Design

C: The RTE Test Plan

D: Test Scripts and Results

E: External Tests and Results

F: RISE Google Earth Procedure

1.2. References

[1] 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

[2] RISE Use Case Document 'Diffuse nutrient leakage reporting to the Water Framework Directive" V1.4, 30 July 2007.
http://www.eu-rise.org/ or http://www.eurogeographics.org/eng/03_RISE_downloads.asp

[3] RISE Data Product Specifications V1.0. 28 September, 2007.
http://www.eu-rise.org/ or http://www.eurogeographics.org/eng/03_RISE_downloads.asp

[4] 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.

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

[6] 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

[7] RISE Conceptual Schema V1.1. 7 September 2007.
http://www.eu-rise.org/ or http://www.eurogeographics.org/eng/03_RISE_downloads.asp

1.3. Terms and Abbreviations

BRGM	Bureau des Recherches Géologiques et Minières
CA	Competent Authorities
CIS	Common Implementation Strategy
COTS	Commercial of the shelf
CRS	Coordinate Reference System
DEM	Digital Elevation Model
DNL	Diffuse Nutrient Leakage
DP	Data Product
DPS	Data Product Specification
EC	European Commission
EU	European Union
FTC	Feature Type Catalogue
GAS	GML Application Schema
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
GML	Geographic Markup Language
hDP	harmonised Data Product
hDPS	harmonised Data Product Specification
IDPR	Indice Développement Persistance des Réseaux
IGN	Institut Géographique National (France)
II	Interactive Instruments
INSPIRE	Infrastructure for Spatial Information in Europe
ISO	International Standards Organisation
JRC	Joint Research Centre
MOTIIVE	Marine Overlays on Topography for Annex II Valuation and Exploitation
MTE	MOTIIVE Test Environment
NIJOS	Norwegian Institute of Land Inventory
NIVA	Norwegian Institute for Water Research
NLS	Swedish Mapping Agency (Lantmäteriet)
NMA	Norwegian Mapping Agency (Statkart)
NTF	Nouvelle triangulation de la France
OGC	Open Geospatial Consortium
OGCE	Open Geospatial Consortium - Europe
PLC	Pollution Load Compilation
QQ	QinetiQ
RB	River Basin
RBD	River Basin District
REGINE	REGIster for NEdbørfelt i Norge (National Hydrometic System in Norway)
RTE	RISE Test Environment
SDI	Spatial Data Infrastructure
SK	Statens Kartverk (Norwegian Mapping Agency)
SLD	Style Layer Descriptor
SMHI	Sveriges Meteorologiska och Hydrologiska Institut (Swedish Meteorological and Hydrological Institute)
SRTM	Shuttle Radar Topography Mission
TRK	Transport, retention och Källfördelning (Transport, Retention and Source apportionment)
UCL	University Collage London
WCS	Web Coverage Server
WFS	Web Feature Service
WFS-X	Translating Web Feature Server
WFD	Water Framework Directive
WISE	Water Information System for Europe

2. RISE Testing System

2.1. Introduction

The main goals of the RISE Project are to:

1) Create a Methodology and Guidelines Document for the creation of geospatial Data Product Specifications (DPS).
2) Test the methodology by creating test harmonised DPS for Hydrography, Land Cover and Elevation.
3) Test the harmonised DPS in an on-line web-based “Test Environment”.
4) Demonstrate the automatic creation of harmonised Data Products from existing databases “on-the-fly” using schema translation.

The last two goals fall within the scope of the RISE “Testing System” developed in the project. The overall system includes the RISE Test Environment (RTE) – an on-line web-based capability aimed at provided facilities for accessing and display of example harmonised Data Products to be used for testing.

In addition, the Testing needs to address:

- Cross-sector (e.g. river sub-basin information combined with land cover).
- Cross-border (e.g. comparison of river networks and lake inventories).
- International Co-ordination (e.g. Different national land-cover classes being aggregated to common subset for use in Diffuse Nutrient Leakage (DNL) modelling).

and

- Demonstrate on-the-fly changing of Map Projection including reference datum conversion (horizontal and vertical).

The testing also needs to encompass the three themes of:

- Hydrography (i.e. catchment area polygons; river and lake segments)
- Land cover (i.e. RISE defined scheme (aggregated Corine type))
- Elevation (i.e. uniform grid of Digital Elevation Model (DEM))

For the purposes of RISE, two test areas were defined:

- Vindån (East Sweden): to help test the cross-sector issues.
- Enningdalsälven (Swedish Norwegian Borders): to help test the cross-border issues.

Figure 2.1. RISE Test Areas: Enningdalsälven & Vindån.

2.2. RISE Test Environment (RTE) Design

The RISE Test Environment (RTE) is an on-line web-based capability aimed at provided facilities for accessing and display of example harmonised Data Products. It employs Web Feature Servers to make the test data available in GML for external testing; and it uses Web Map Servers (WMS) to allow the test data to be displayed and compared to other data layers within the RTE.

In a real world implementation, a harmonising service would be based upon the components described in the figure below. (*Figure needs tidying up a little*)

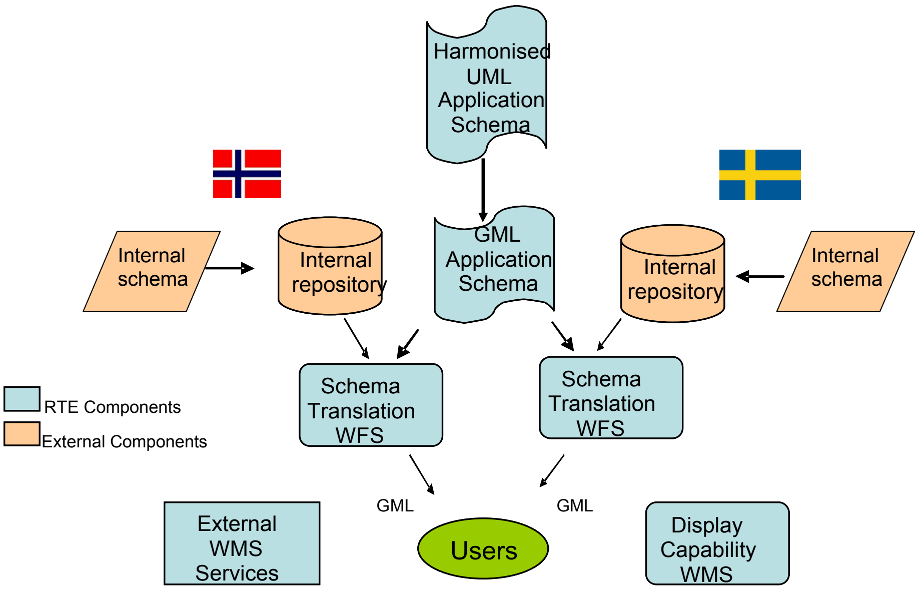


Figure 2.2. Main components of RISE Test Environment.

The data would be the property of the respective data providers (in the figure associated with Sweden and Norway). These data are implemented in (possibly) different data bases according to their respective internal schemas, which again are compliant to the national conceptual models if they exist. The conceptual models and their internal schemas and repository are different from vendor to vendor.

In practice, for the RISE Project, in order to avoid conflicts with the vendors' original databases, the data was exported from the vendors to the RISE Test Environment, hosted by QinetiQ and Interactive Instruments (working in the consortium through OGC-E). This allowed comprehensive testing, with a distributed scenario, without influencing the vendors' data stores. Secondly, the testing would not be complicated by national authorisations and identification protocols, which are not a part of the RISE Project.

The following diagram illustrates the basic concept behind the RTE implementation. The test data is ingested into the system and stored in an Oracle Database. Transformation services, driven by GML Application Schemas (GAS), are able to convert the data, on the fly, to data which is conformant to the harmonised Data Product Specification. The Data Products can then either be downloaded directly or displayed. Downloaded data can then be further tested in an external GIS.

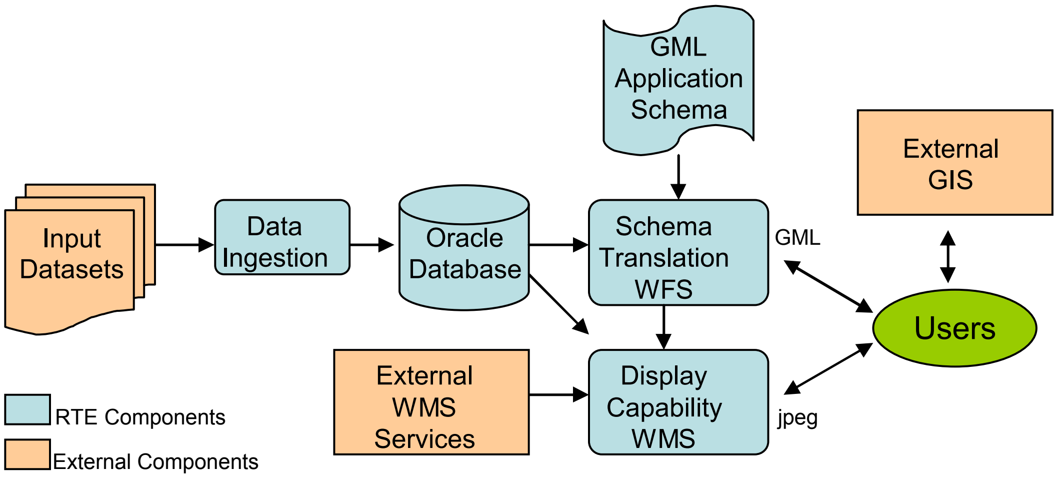


Figure 2.3. Main components of RISE Test Environment.

As mentioned above, two implementations of the database and Schema Translation have been implemented, one at QinetiQ and one at Interactive Instruments. This allows the interoperability of different software implementations to be demonstrated.

More details of the full RTE implementation are given in Appendix B.

2.3. Test Plan

The testing carried out in the RTE consisted of system tests, followed by a number of product tests.

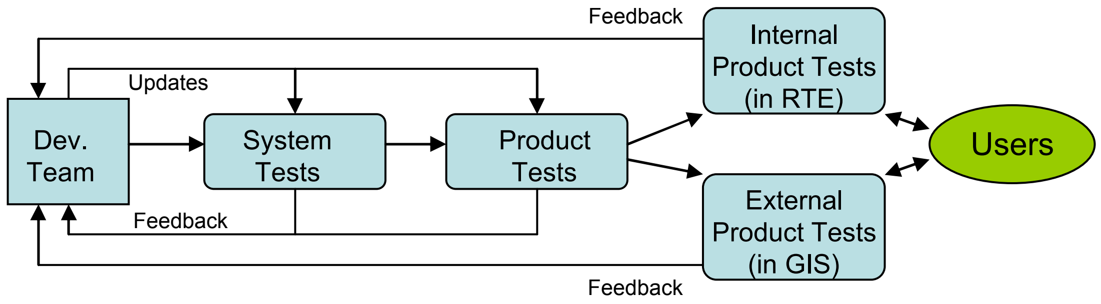


Figure 2.3. The test components and test life-cycle.

The system testing was carried out by the RISE Software Development Teams (at QinetiQ and at Interactive instruments).

This was followed by Product Testing, first by members of the RISE Consortium and then by other Users. There are no fixed boundaries between the phases and the whole process was iterative in nature with comments being fed back down to the Development Teams and revised functionality being inserted and tested up the chain.

There are also external tests that can be carried out on the products served by the system. These are documented in Appendix D. A detailed Test Plan is provided in Appendix C.

3. Use Case Requirements, Tests and Results

3.1. Introduction

RISE has carried out a Use-Case analysis [1] to test the RISE Methodology and Guidelines [2]. The analysis identified the activities and issues in the Use-Case scenarios and allowed the RISE harmonised Data Product Specifications [3] to be defined for hydrography, land cover and elevation.

In order to test the harmonised Data Products Specifications the Project has generated associated example Data Products and investigated how well they address the issues of concern within the Use Cases.

The specific topics of interest within the Use-Case themes were:

- River-Basin District overview information.
- Surface Water Body Categorisation.
- Land cover information creation for Diffuse Nutrient Leakage (DNL) modelling.
- Comparison of real with theoretical drainage network.

This Section proceeds to discuss these issues in more detail, presents the RISE solution and gives examples of the test results. Some of these results also demonstrate interoperability with external OGC-compliant information servers.

3.2. River-Basin District Overview Information

3.2.1. Issues

The Water Framework Directive (WFD) [4] requests data on River Basin Districts, River Basins and primary catchments (sub river basins - the smallest units in the catchment's 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 [5].

The main RISE issue here is the need to add the national ID to the existing national river basin codes. The structure of the national code is up to each member state. The European id (eu_riverBasinCode in the RISE UML) is constructed by adding a two letter identifier (e.g. SE for Sweden, NO for Norway) to the beginning of the national id.

The challenge is to be able to output data products with the necessary European id without having to update the associated national databases.

3.2.2. RISE Solution

It is relatively straightforward to add constant character strings to existing features to create new features with schema-translation software. Appendix B illustrates the process making use of Snowflake Software's Go Publisher package.

3.2.3. Test Results

The following Figure gives an example of the start of a river basin data product in GML showing the presence of the necessary eu_riverBasinCode constructed, on the fly, from the national code.


```
<?xml version="1.0" encoding="iso-8859-1" ?>
<!-- Created by GO Publisher WFS v1_2_5a Build 311 from 2007/05/30 13:53 -->
<!-- Snowflake Software Ltd. (http://www.snowflakesoftware.co.uk) -->
- <gml:FeatureCollection xmlns:gml="http://www.opengis.net/gml" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:gsr="http://www.isotc211.org/2005/gsr" xmlns:gss="http://www.isotc211.org/2005/gss"
  xmlns:gts="http://www.isotc211.org/2005/gts" xmlns:smil20="http://www.w3.org/2001/SMIL20/"
  xmlns:gmd="http://www.isotc211.org/2005/gmd" xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:gco="http://www.isotc211.org/2005/gco" xmlns:RISE="http://www.eu-rise.org/umlmodel"
  xmlns:smil20lang="http://www.w3.org/2001/SMIL20/Language" xmlns:xlink="http://www.w3.org/1999/xlink"
  xsi:schemaLocation="http://www.eu-rise.org/umlmodel http://www.pinkbox.space.qinetiq.com/RISEnew.xsd
  http://www.opengis.net/gml http://schemas.opengis.net/gml/3.1.1/base/gml.xsd">
 - <gml:featureMember>
  - <RISE:RiverBasin gml:id="RiverBasin.112000">
      <RISE:eu_riverBasinCode>SE112000</RISE:eu_riverBasinCode>
    - <RISE:name>
        <gco:CharacterString>Enningdalsälven</gco:CharacterString>
      </RISE:name>
```


Figure 3.1. Example river basin product showing the constructed European id.

3.3. Surface Water Body Categorisation

3.3.1. Issues

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. In a similar way to the river basin code, the structure of the national surface water body code is up to each member state, the European code is constructed from this by adding the national identifier. This issue was addressed above (Section 3.2) and is not covered again here. Surface water bodies are also to be categorized into rivers, lakes, coastal waters and transitional water; and are to be reported on a river basin district basin. In the RISE Use Cases only the river and lake categories were required because of the locations of the test areas.

A problem arises when a river basin crosses a national boundary and so information from two different countries has to be combined, taking into account different map projections and different representations. This is the case for the RISE Enningdalsälven River Basin in which data from Sweden is in the RT-90 projection and data from Norway is in the UTM-33 projection.

3.3.2. RISE Solution

Many WFS implementations include the ability to carry out geospatial re-projection on the fly and so this makes it easy for users to combine data that originally had different projections. In the RISE Test Environment, the Interactive Instruments WFS (XtraServer) implementation allows a choice from a number of different projections, including UTM33, RT90 and straight lat/long (EPSG:4326). The GetCapabilities call to a WFS should list the output projections which can be handled. It should be noted that if sub-selecting the data based on geospatial co-ordinates, then the projection of the selection criteria can also be specified – and this can be different to the output projection selected. The available options for the “filter” projection are also specified in the response to a GetCapabilities call.

In the RISE case, the RISE Viewing Client accesses and displays the data in lat/long and this makes it easy to compare with data from other external WMS servers which may not be able to handle a wide range of different projections.

The RISE Test Environment (RTE) provides a number of examples demonstrating the capability of selecting different filter projections and different output projections for the GML Data Products.

3.3.3. Test Results

Figure 3.1 illustrates the problem for combining data from different sources in the cross-border Enningdalsälven River Basin. The Norwegian dataset extending to the border and lakes at the border are truncated to the actual border. (This can cause problems in calculating statistics of lake sizes.) The Swedish Dataset also extends to the border, but lakes which cross the border are presented in full. However, the Swedish lake data has been compiled to a lower spatial resolution compared to the Norwegian dataset.

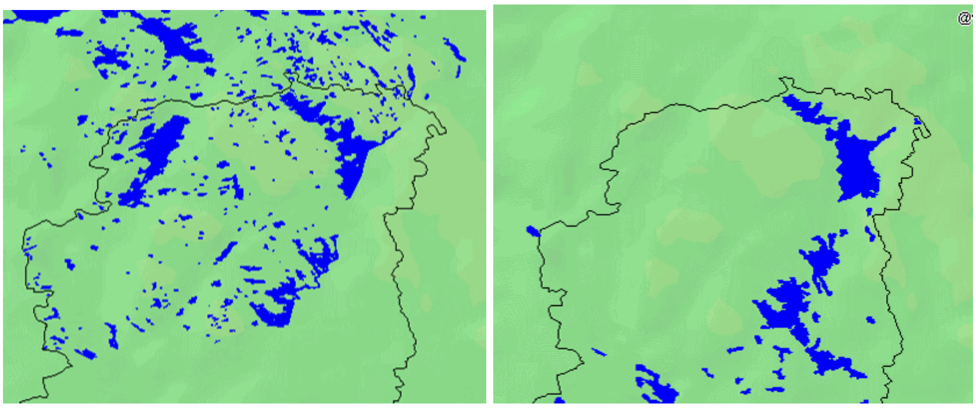


Figure 3.1. Norwegian (Left) and Swedish (Right) Lake datasets in cross border area showing how Norwegian lakes are truncated to the border.

Having access to data in a common projection makes it easy to inter-compare the data and compare it to other datasets for quality control purposes.

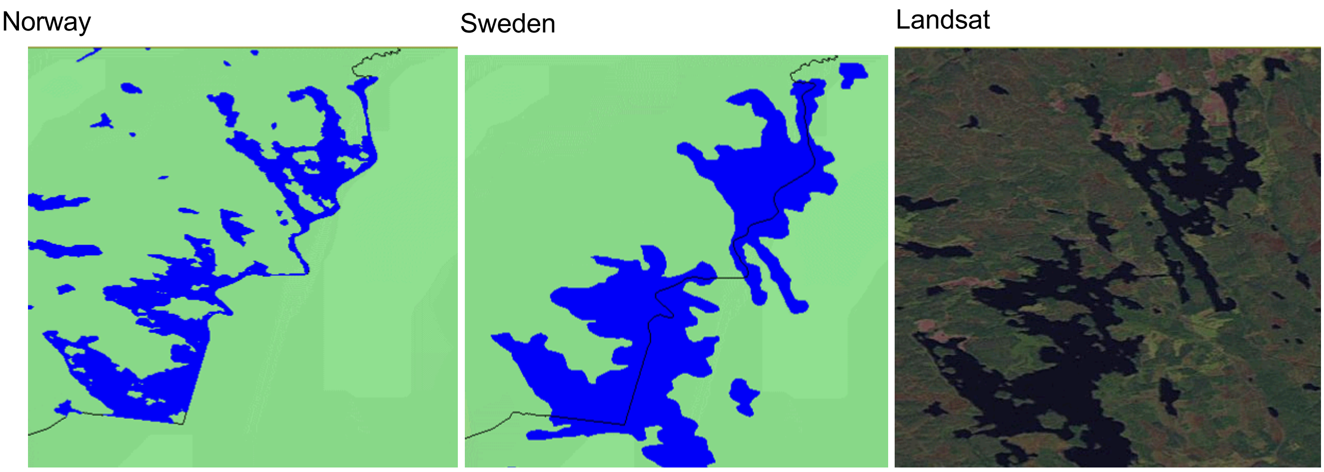


Figure 3.2. Norwegian and Swedish lake information compared to Landsat Satellite image.

Taking the two lake data products in the same projection from the relevant WFS services makes it much more straight forward to combine the two datasets into a single product. Matching the data and removing duplicate lakes is beyond the scope of the Rise Test Environment (which is mostly concerned with issues relating to schema translation). The merging of the two datasets in a GIS is the subject of the Hydrography External Test reported in more detail in Appendix E. Figure 3.3 illustrates the result of this merging.

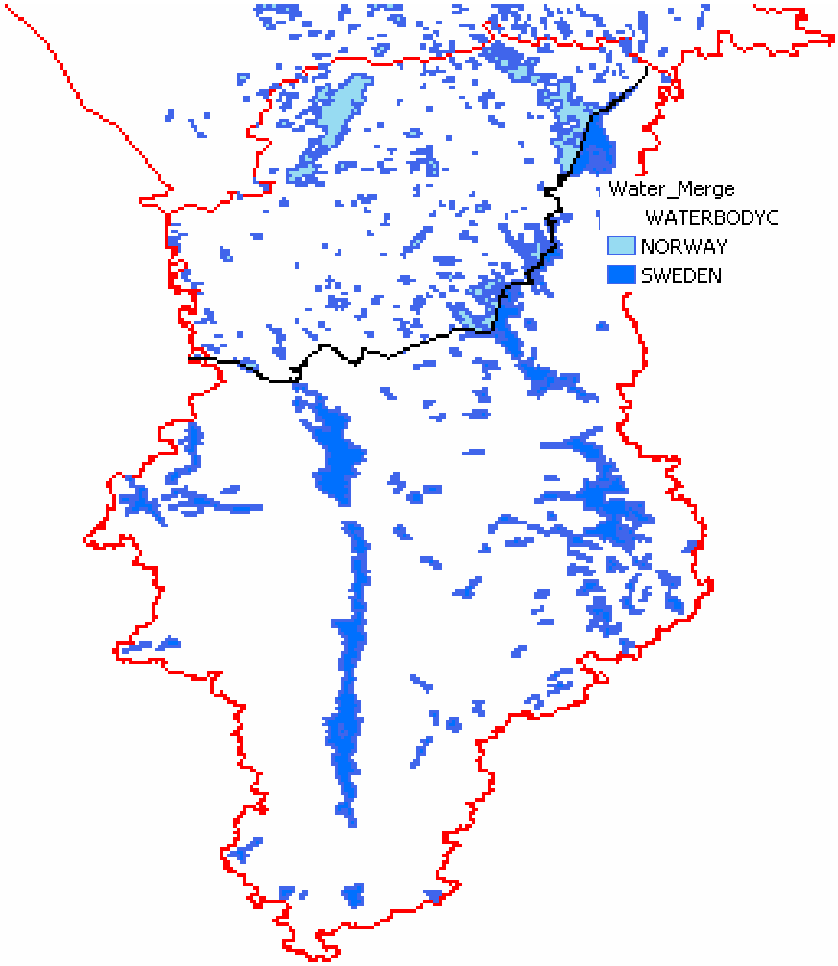


Figure 3.3. Example display of merged Norwegian and Swedish Lake data for the Enningdalsälven River Basin.

3.4. Land Cover Information Creation

3.4.1. Issues

RISE addressed the issue of land cover data processing as it could be used to illustrate the aggregation of feature-types in the schema-translation process. However, the potential applications of land cover data are very broad and, after much debate, the RISE Project chose to use the example of the data requirements for Diffuse Nutrient Leakage (DNL) modelling for the Water Framework Directive (WFD) to develop a scenario.

National land cover information tends to use a classification scheme which suits the national requirements and these can differ markedly from country to country. Reconciling the different national schemes in a cross-border area, or in response to European reporting requirements, is not a trivial matter.

Following an analysis of the issues (e.g. Euroharp [6]), it was recognised that requirements for DNL modelling across Europe are complex and there are a number of harmonisation issues. However, it was recognised that, for the purposes of RISE, tackling the problem of harmonising the input data for modelling could be illustrated with a limited number of different land cover classes. Schema translation could be used to show how existing datasets could be mapped into a new classification scheme without modifying the underlying data. The RISE Use Case Document [2] describes the relevant situation in Sweden and Norway. The RISE harmonised DPS does not provide the definitive solution but is intended to illustrate a process which could be used in a real situation.

3.4.2. RISE Solution

RISE defined a limited number of land-cover classes suitable for DNL modelling. This list was not intended to be definitive and would probably have to be revised in any real application of the process. Nevertheless it was sufficient to illustrate the process. The defined classes were:

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

Mappings from the existing Swedish and Norwegian land cover classification schemes were developed and implemented in a translating web feature server (WFS-X). QinetiQ made use of the Snowflake Go Publisher software and Interactive Instruments made use of the XtraServer software.

3.4.3. Test Results

The RISE Test Environment provides access to the “harmonised” land cover data products. Again, the ability to access the data in a number of different projections is helpful to an analysis of the data. The following Figure shows a comparison of RISE land cover classification with a Landsat satellite image of the same area. (The complex line structure in the classified image indicates the granularity of the input land cover classification scheme).

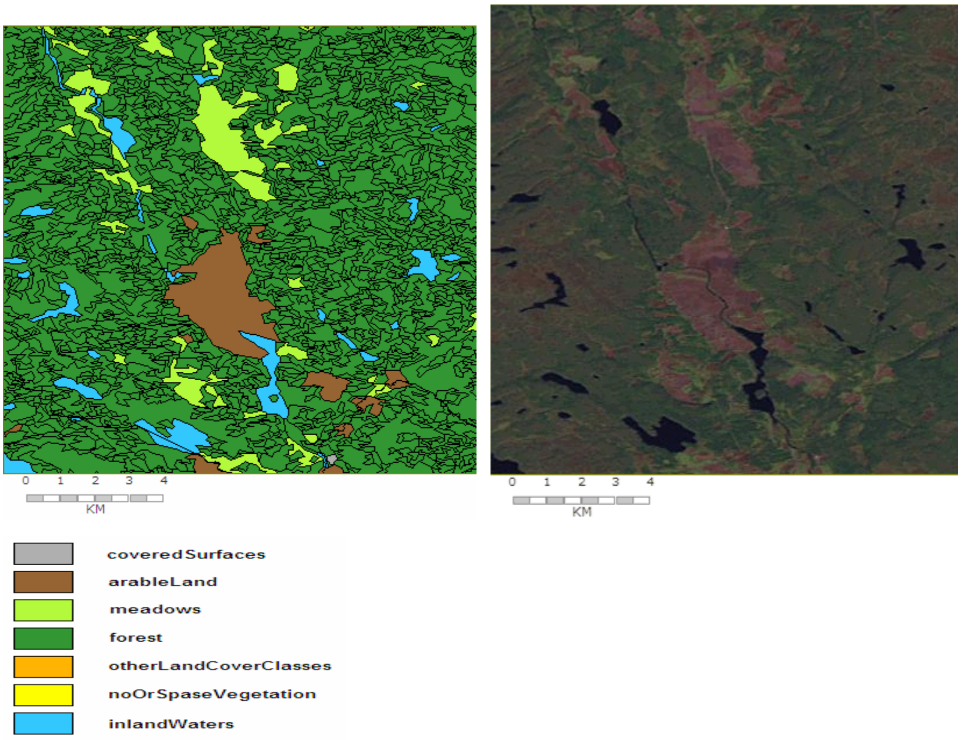
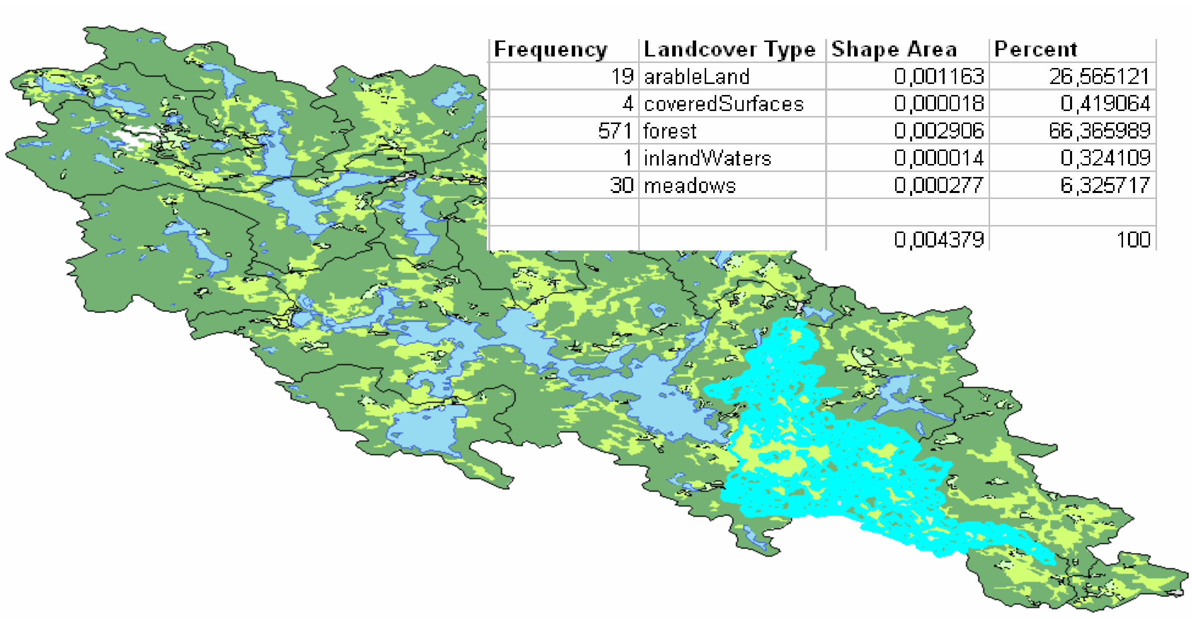


Figure 3.4. Comparison of RISE land cover classification with Landsat satellite image. The complex line structure in the classified image indicates the granularity of the input classification scheme.

The land cover data can be downloaded from the WFS and then processed in a GIS as required. The External Tests presented in Appendix E provide a number of examples of this. The following Figure shows the results of the analysis of the % coverage of the various RISE land cover classes for a river sub-basin in the Vindån River Basin.



Frequency	Landcover Type	Shape Area	Percent
19	arableLand	0,001163	26,565121
4	coveredSurfaces	0,000018	0,419064
571	forest	0,002906	66,365989
1	inlandWaters	0,000014	0,324109
30	meadows	0,000277	6,325717
		0,004379	100

Figure 3.5. An example of land cover data analysed for a given river sub-basin in Vindån to obtain the % coverage of the RISE Land Cover Classes.

3.5. Considering clear-cuts in the land cover information

3.5.1. Issues

Land cover data for a country can be difficult to keep up to date. In particular, for example, as a result of the cutting down of forest areas, the land cover can change on relatively short time-scales. RISE has investigated the issue of merging two datasets on-the-fly in order to produce an up-to-date land cover product without changing the underlying databases.

3.5.2. RISE Solution

In Sweden, a data set describing the forest clear-cut areas are provided by the Swedish Forestry Board on an annual basis. Thus, a more up-to-date description of the forest areas could in principle be derived by subtracting the clear cut areas from the forest areas and classify the clear cut areas as areas with "sparse or no vegetation".

It is possible to implement this process within a WFS that supports on-the-fly transformation and without altering the underlying source data sets. The process is translated into database queries covering both datasets.

3.5.3. Test Results

This is a demanding task as it requires on-the-fly creation of features and very complex geometric queries across data sets. The following describes experiences with configuring this requirement in the XtraServer test environment.

First a union of all the clear-cut-geometries was subtracted from the forest-geometries. The advantage of this approach is that no effort has to be made determining which clear-cuts should be considered (as all are considered). However, building a union of geometries results in a very poor performance (exponential, as the database management system tries to join components of the union-geometry while many of the individual geometries are not adjacent), so the time for executing the whole query in the database management system lay in the range of about an hour alone.

To improve performance, a different approach was evaluated: For each forest only those clear cuts intersecting the forest are determined by a spatial query. Then, a union of only those was created and then subtracted from the forest areas. This improved the performance of the query in the database to about 12 minutes, which was acceptable for downloading data, but is not acceptable for interactive applications.

The performance overhead of using a WFS is minimal, the execution time is spent in the database management system executing the spatial queries, in this case ORACLE 10g.

3.6. Comparison of real with theoretical drainage network

3.6.1. Issues

There are currently very few direct elevation information requirements in the Water Framework Directive (WFD). However, for the WFD reporting in France, Bureau des Recherches Géologiques et Minières (BRGM) has provided the calculation of the Indice Développement Persistence des Réseaux (IDPR) for the river 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,
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.

For the IDPR analysis in France, two data sources are used: Elevation data 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. The RISE Use Case Document [2] provides more information.

There are no schema translation issues with regard to the handling of DEMs. The issues of concern relate to re-projection of the data, re-gridding the data to a suitable spatial resolution and outputting the data in a suitable format.

3.6.2. RISE Solution

The three issues of concern mentioned above, namely, re-projection, re-gridding and output formatting can be handled by an OGC compliant Web Coverage Server (WCS). The Minnesota WCS has been implemented within the RISE Test Environment and this is able to demonstrate the required functionality.

In general, a WCS can output data in a number of different formats. For the purposes of RISE we choose to use the 16-bit geoTiff format as this offers the most compatibility with GIS functionality.

In addition, to assist with the visualisation of DEM data in the RISE Viewing Client, a grey-scale image of the DEM was generated and made available through the RISE WMS. For comparison, a 3” spatial resolution colour hill-shaded SRTM dataset was also accessed (from a WMS service at UCL, London).

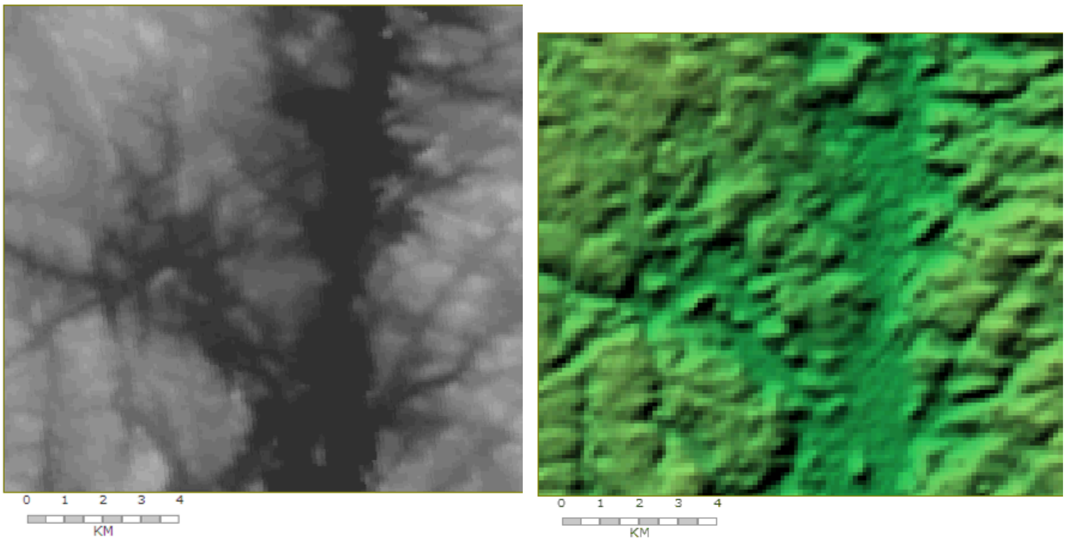


Figure 3.6. Comparison of greyscale visualisation against a colour hill-shade representation of elevation derived from (different) uniform grid DEMs.

3.6.3. Test Results

For modelling purposes, direct access to the WCS is required and this is made available through the RISE Test Environment. The RISE test shows how DEM data from Norway and Sweden can be harmonised and merged and used to carry out a river network analysis (thalweg generation) for a cross-border river basin.

The following Figure illustrates the results of the analysis showing the theoretical river network compared to the actual river network data from Norway. Further details are provided in Appendix E.4.

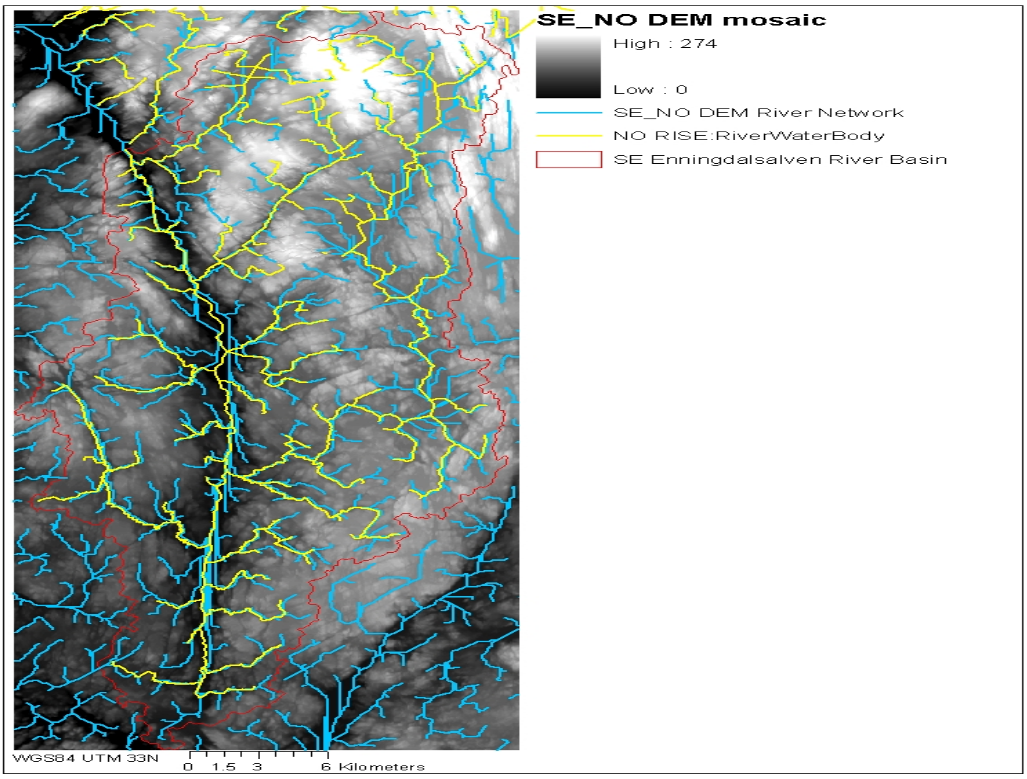


Figure 3.7. Theoretical river network (blue) derived from merged DEM, compared to Norwegian river network data (yellow) for the cross-border Enningdalsälven river basin (red).

4. Interoperability Issues

The adoption of standard OGC interfaces, particularly in the case of the Web Map Server (WMS), allows integrated access to a range of information services. The following sections provide some examples.

4.1. Other WMS Services

The RISE Viewing Client has been designed to allow access to other WMS Services and select additional layers of information to be made available for display. In order to find out what layers are available, the Client is able to make a GetCapabilities call and list the available layers (by entering the GetCapabilities URL of the Server and clicking on the "Load" button). The available layers are then displayed, and clicking on the relevant "add to map" link, adds the selected layer to the layer list on the left of the map window. The display of that layer can then be turned on or off as required.

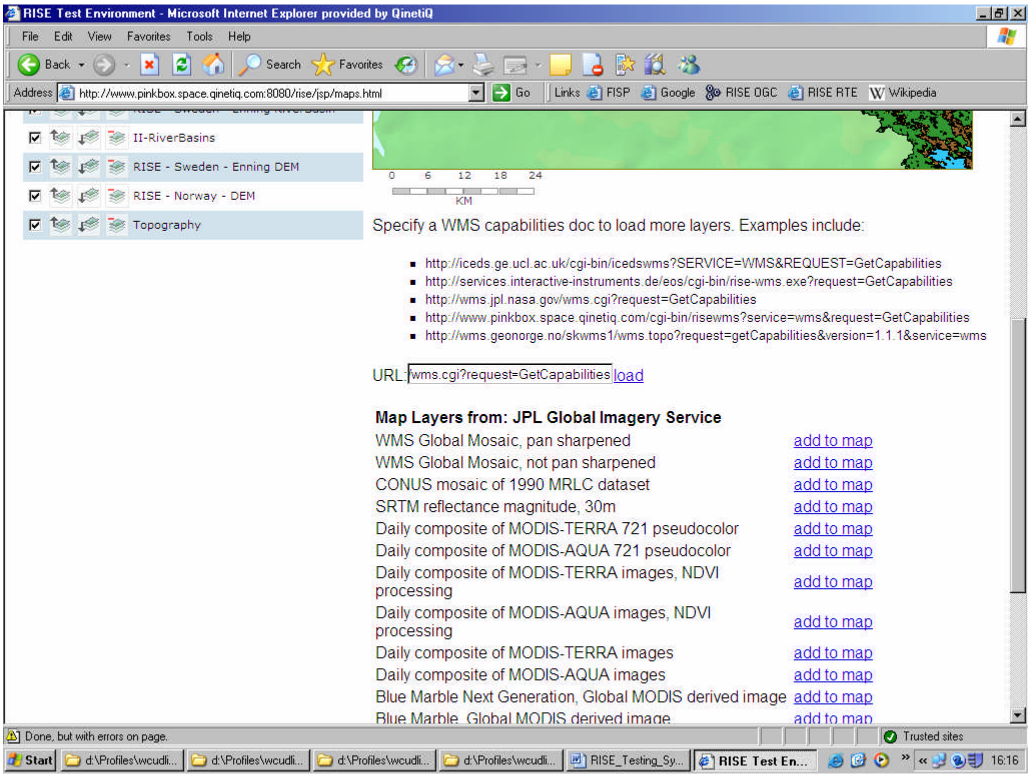


Figure 4.1. Part of RISE Viewing Client showing how available layers from other WMS services can be listed and selected for display.

The Client screen includes some example GetCapabilities calls to servers which contain relevant information to RISE. Identified Servers include:

- **ICEDS:** a range of satellite based global datasets including Landsat 5 (from around 1990) and Shuttle SRTM DEM data.
- **Interactive Instruments:** This is an alternative source for some of the RISE hydrography data for Sweden. This illustrates how the same data can be made available from servers from different manufacturers.
- **JPL (OnEarth):** Provides access to a range of global-mosaic satellite imagery, including Landsat 7 (from around 2000). This was the source of Landsat imagery used earlier in Figures 3.2 and 3.4.

- **RISE (pinkbox):** Provides access to all the data layers in the RISE WMS. This includes data for the Vindån River Basin in the East of Sweden.
- **Digital Norway (geonorge):** Provides access to the Digital Norway WMS Service. (http://www.statkart.no/Norge_digitalt/Engelsk/). This provides access to a range of geographic mapping data for Norway. However, it should be noted that access to the site is restricted to registered users. Once approved, authorisation is based on the registered IP address of the User. This example shows how interoperability through a generic client can be extended to include servers which require authorisation prior to access.

The following Figure gives an example of the RISE Viewing Client display showing the Enningdalsälven lake and river network superimposed on Landsat satellite imagery. Appendix D.4 provides further information on the procedure to be followed to achieve this type of display.

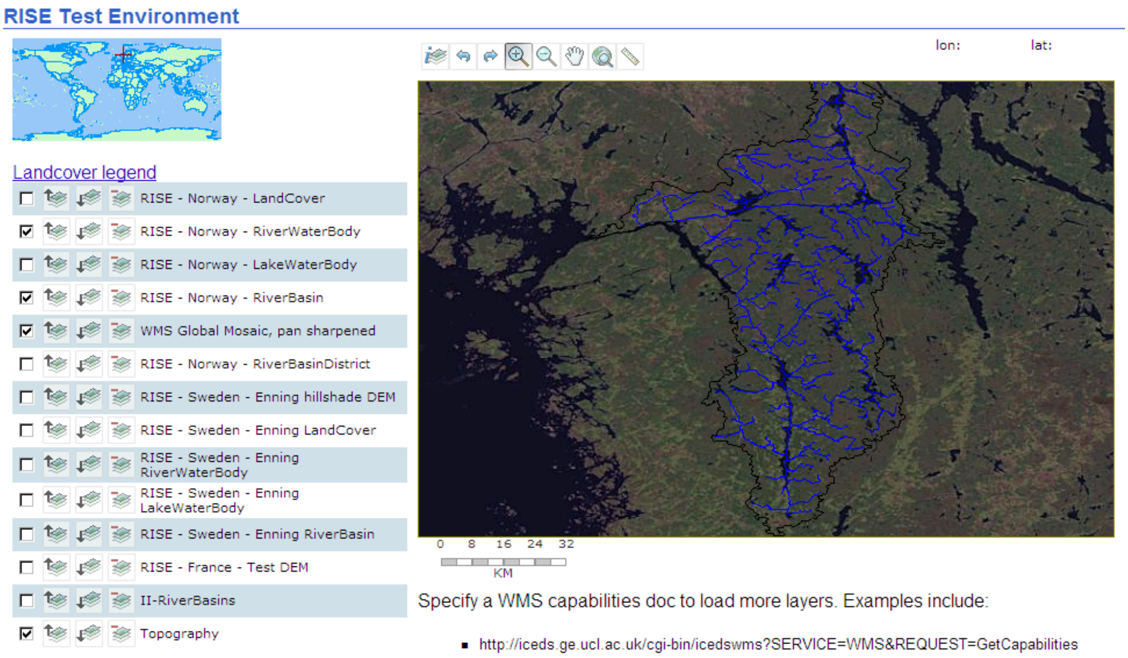


Figure 4.2. Enningdalsälven lake and river network superimposed on Landsat satellite imagery, displayed in the RISE Viewing Client.

4.2. Google Earth

The Google Earth Client now has a capability to include information layers served through any OGC-compliant WMS. Appendix F outlines the procedure for accessing RISE information layers in this way. The following Figures give some example displays.

Figure 4.2. Norwegian and Swedish lake data displayed in Google Earth.

Figure 4.3. Swedish land cover data, in perspective view, displayed in Google Earth.

5. Summary and Conclusions

A major objective for the RISE Project was to not only produce a Methodology and Guidelines document, but also to test the procedures for a number of Use Cases, and to test the Application Schema associated with the harmonised Data Product Specification. In order to test the Application Schema, the Project has developed the RISE Test Environment (RTE). This is an on-line web-based resource to facilitate the access to example harmonised Data Products, and to facilitate the display and testing of these products.

The tests need to cover the themes of hydrography, land cover and elevation; and the RISE Use case analysis was used to derive specific test requirements for:

- River-Basin District overview information.
- Surface Water Body Categorisation.
- Land cover information creation for Diffuse Nutrient Leakage (DNL) modelling.
- Comparison of real with theoretical drainage network.

Test data for two regions in Scandinavia were obtained from various organisations in Sweden and Norway. The test areas were the Vindån river basin in the East of Sweden and the Enningdalsälven river basin in the west of Sweden and on the border with Norway. The Vindån test area has been used to demonstrate cross-sector interaction and the Enningdalsälven test area allowed additional cross-border issues to be addressed.

The tests have also shown how harmonised Data Products can be generated as required through the use of translating Web Feature Servers (WFS-X); with the data being downloaded and exploited in GIS applications. Web Coverage Servers (WCS) are also able to satisfy many of the harmonisation requirements for Digital Elevation Models (DEMs) including re-sampling and re-projection.

The RTE has been built using a combination of free open-source software and commercial packages. These include the Minnesota Map server (with WMS and WCS), Interactive Instruments' XtraServer (with WMS and WFS), Snowflake Software's Go Publisher (including WFS) and Oracle's database 10G. Databases and data servers have been installed at both QinetiQ in the UK and Interactive Instruments in Germany in order to demonstrate interoperability and differing functionality between the different software solutions.

The range of tests carried out has been able to demonstrate on-the-fly creation of harmonised Data Products from existing datasets without modifying the underlying database. The necessary schema translation is carried out through a combination of creating new "views" of the data in the database and additional mappings in schema translation software.

Overall, the RISE Testing System has shown the viability of schema translation combined with standards-based information servers as a way of creating new Data Products to satisfy relevant harmonisation requirements without re-engineering existing databases.

It should be noted that RISE adopted the GML 3.1.1 Standard for the GML Application Schema. This is a relatively new version of the GML standard and most software tools have not been updated to allow access to the full capabilities offered by GML 3.1.1. Some "work arounds" and format translation had to be employed in the testing process to overcome some of the existing short comings. The need for these will reduce as the software tools continue to evolve.

Similarly, the functionality offered by WFS differs between the various available software packages, particularly with regard to their re-projection capabilities and their ability to support queries. However, the available software is continuing to evolve and the functionality is improving all the time.

It has also been possible to show interoperability between OGC-compliant WMS information services, with data from distributed servers being displayed in a single map window. The ability to display RISE information layers in the Google Earth client has also been demonstrated. Given the widespread use of Google Earth within the GIS community and the general public, this integration helps show the benefit of harmonisation and the adoption of interoperable standards.

The RISE Test Environment can be accessed at:

http://www.pinkbox.space.qinetiq.com:8080/rise/welcome.jsp

A username and password are required and these can be obtained by sending an email to wcudlip@qinetiq.com.

Appendices

The Appendices present the testing requirements in a more formal manner and provide further information on the design of the RTE together with more extensive results of the testing.

A: RTE Requirements.

B: RTE Design.

C: RTE Test Plan.

D: Test Scripts and Results.

E: External Tests and Results.

F: RISE Google Earth Procedure.

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