Interoperable GMES services for marine pollution monitoring and forecasting in European regional seas

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Abstract – In marine and coastal areas, users in several countries and organisations need access to the same data, including observations, derived parameters and predictions of future conditions. Interoperable services necessitate standardisation of system communication protocols and harmonisation of data and metadata formats. The services presented in this paper are based on established web-GIS and web services standards, and have been developed in line with INSPIRE recommendations. Several regional portals for harmful algal blooms and oil spill monitoring have been established to demonstrate interoperable services to selected end-users. In addition, a pan-European service system has been established in the InterRisk SSE portal. Standardised tools are available for setting up services and portals and once OGC compliant nodes are in operation they can provide products to multiple portals with no extra effort on the provider's side. Feedback from users and experiences from the regional portals will be used to further develop the systems into sustainable GMES services.

Keywords: Web-GIS, Web Map Server, GMES, INSPIRE, interoperable services, marine pollution

1. INTRODUCTION

The InterRisk project is developing a pilot system for interoperable GMES monitoring and forecasting services for environmental risk management in marine and coastal areas. The InterRisk pilot is comprised of an open system architecture based on noted GIS and web standards in line with INSPIRE recommendations (IDT, 2007), and integrates services for several European regional seas. The pilot system will be validated by users who need data on oil spills, harmful algal blooms and other marine pollution events, in Norwegian, UK, Irish, French, German, Polish and Italian coastal waters.

The InterRisk services will include basic services like satellite data processing, in situ data delivery, ocean model simulations, metadata catalogue access, as well as complex services like oil drift prediction and ecosystem modelling. The network of InterRisk services will be embedded in the European Space Agency's Service Support Environment (SSE) (ESA, 2004), which provides the underlying infrastructure. This will enable service providers to make their data products and services available to the GMES user community through a common portal. In addition, value-adding companies can develop new services by combining existing ones and deliver these new services through the same portal. End-users are free to choose from all available services, selecting the one(s) best suited for their needs. It is expected that the developed components, both services and infrastructure, can be used to build up sustainable GMES services.

2. SERVICE CONCEPTS

In pollution monitoring and forecasting, it is desirable to incorporate data from all available sources to obtain the best possible basis for decision-making. The InterRisk services are based on this concept, integrating remote sensing data from satellites and aircrafts, in situ observations from vessels and buoys, as well as predictions made by numerical models. Each data source go through a series of processing steps, including initial acquisition, quality control and archival, generation of derived and combined products, and distribution of these products through a standardised web-GIS (Figure 1). This concept facilitates multiple providers – multiple end-users service networks where a provider can reach a number of end-users (clients), and an end-user can seamlessly access products from many providers.

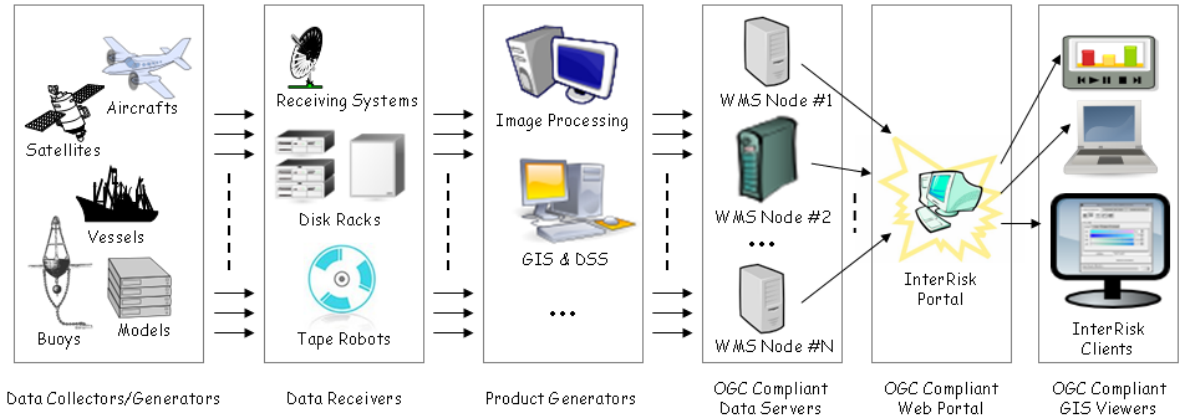

Figure 1. The service chain from input data to products accessible from the DISPRO portal.

The existing processing chains for data and product generation, which are typically performed by legacy systems using non-standard or proprietary data and metadata formats, can be retained by the service providers. To serve their products through the InterRisk portal, they need only establish a WMS or WFS compliant node publishing these in one of the standard data and metadata formats endorsed by the OGC (OGC, 2008). The end-users on the other hand, can access all available products using a common web browser; no extra plug-ins needed.

At the heart of the service network, the InterRisk portal mediates all end-user requests to respective providers, and delivers the desired products back to the end-users. The network of providers can grow dynamically. As soon as a new OGC compliant node becomes operational, it can register its products with the portal, which will then offer them to interested end-users. The InterRisk portal also provides additional services for both providers and end-users (Figure 2). For instance, providers can chain existing services to generate new value-added products, and end-users can search for services covering a certain area or interest and/or within a certain thematic application (such as “oil spills”).

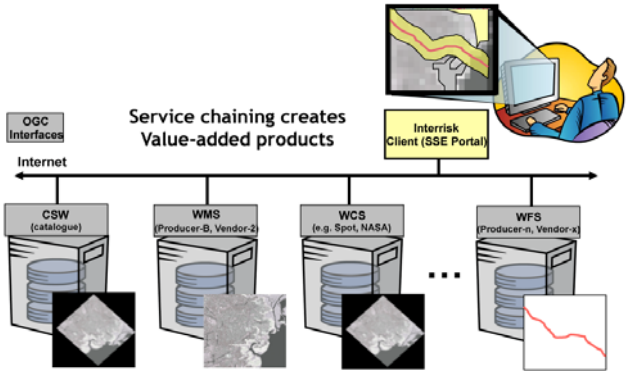

Figure 2. The InterRisk SSE architecture.

The chosen approach has several benefits. As mentioned above, it supports many-to-many networks of providers and end-users, and there is no need for special software on the end-users part. Furthermore, the chosen OGC standards are widely adopted by both academia and commercial actors, and mature software tools are available for setting up a OGC compliant node. This also includes open source tools, of which the University of Minnesota MapServer is the most commonly used. Adhering to established standards and use of proven tools will reduce the initial development costs as well as the maintenance costs, and contribute to the developed services becoming sustainable.

3. EXAMPLES OF REGIONAL DEMONSTRATIONS

3.1 Harmful algal bloom service in Norway

The Norwegian Harmful Algal Bloom (HAB) service, NORHAB, aims to deliver daily information for monitoring and assessing algal bloom situations along the coast of Norway. Fish farming is an important industry in these waters, and having a system for early warning of HAB situations is of large economic interest (Folkestad et al., 2007). For this purpose a combination of remote sensing data covering large areas but with a resolution of approx 1 km, and ferrybox instruments mounted onboard vessels providing much better spatial resolution but only at sample points along the vessel track, is useful.

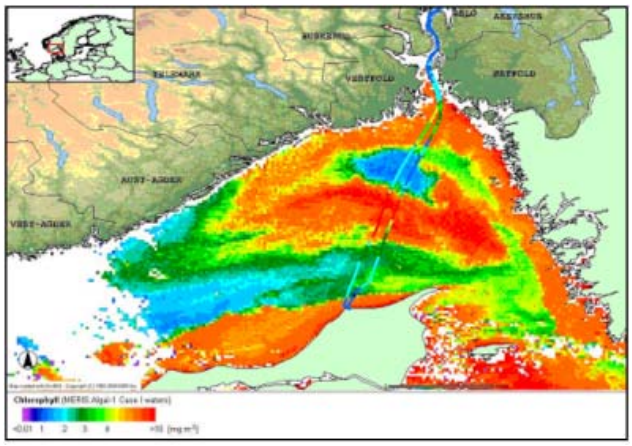

Figure 3. Combining Envisat MERIS chlorophyll-a data with Ferrybox observations in the Skagerrak area.

Figure 3 illustrates chlorophyll-a products derived from satellite and in situ sensors, respectively. Ocean colour sensors are affected by cloud conditions, and only part of the ocean areas can be mapped each day. An important supplement to satellite data is ferrybox measurements which provide validation data for the satellite products and can be obtained regularly. Water samples taken by the ferrybox system can also be used to identify the specie or species occurring in a high concentration area is toxic or not. For periods with cloudy weather, weekly averages of satellite-derived chlorophyll-a are used to increase the coverage of the area of interest.

3.2 UK and Irish Water Quality and HAB service

Figure 4 illustrates how data from many providers can be combined in the UK and Irish Waters InterRisk portal. Remote sensing data are provided by Plymouth Marine Laboratory (PML) and NASA; the latter is not a member of the InterRisk consortium but can still provide data as they offer a WMS compliant data server. PML also provides several other products: background data such as bathymetry and coastline is overlaid on top of the raster layers, as are in situ data from offshore stations.
Several providers offer model forecasts. The UK met office provides forecasts of chlorophyll-a in the English Channel, while met.no (the Norwegian Meteorological Institute) also provides standard meteorological forecasts (wind) for UK and Irish Waters. Met.no also provides phytoplankton forecasts from an ocean-ecosystem model covering a large part the North Sea including northern UK waters. The same WMS server at met.no is used for delivery of the model forecasts to both the NORHAB portal and the UK and Irish Waters InterRisk portal. This illustrates that once a provider has established a WMS compliant data server, he can deliver data to any portal, without any further development or maintenance costs on the provider side.

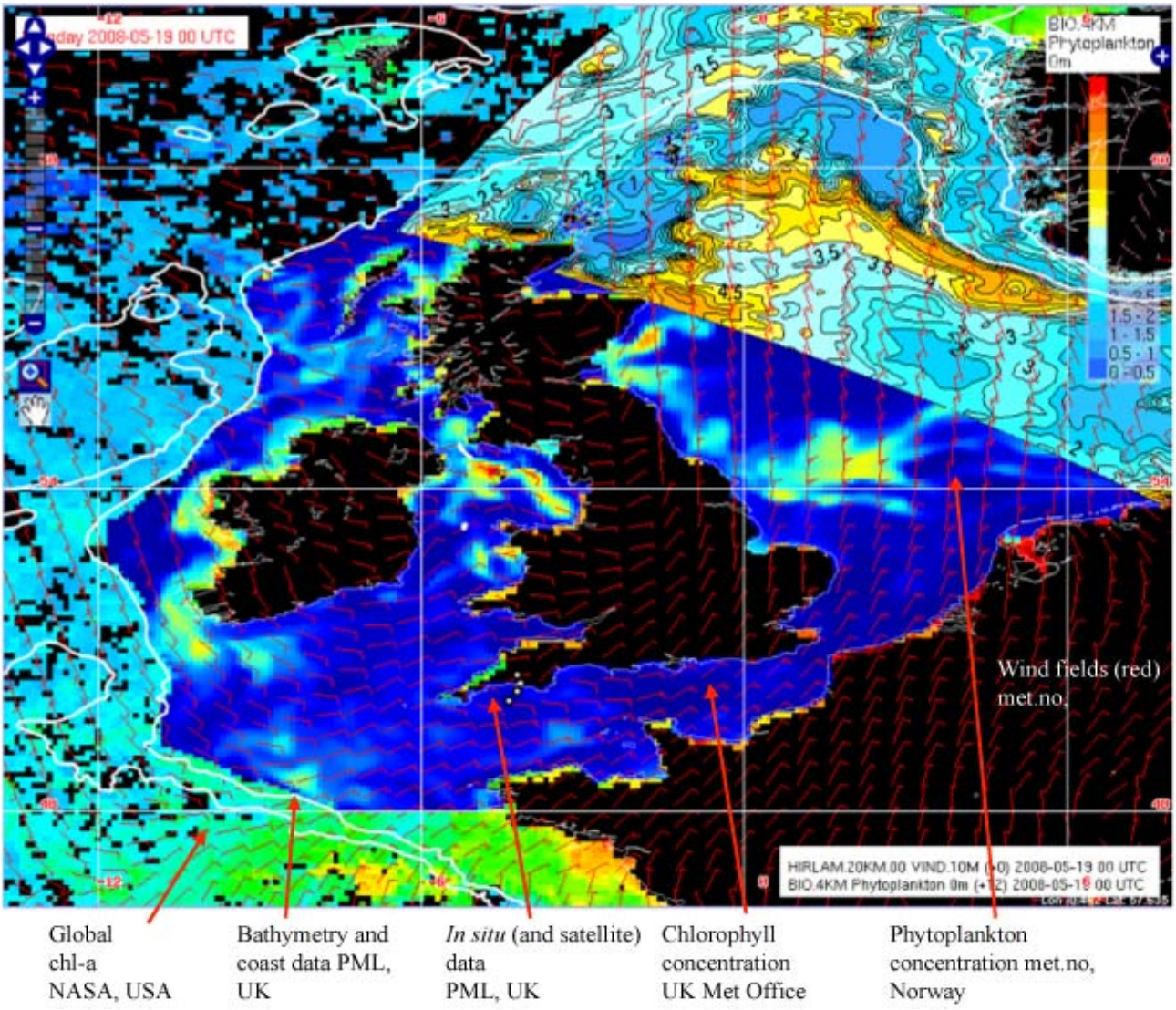

Figure 4. Combining data from many providers in the UK and Irish Waters InterRisk portal.

3.3 A pan-European test service in the InterRisk SSE portal

A pan-European service system has been established in the InterRisk SSE portal, where several services developed in InterRisk have been registered. Figure 5 illustrates how a SAR-based oil spill monitoring service can be accessed in this portal. Other services in this portal include, among others, an Envisat MERIS chlorophyll-a service for UK and Irish Waters, a novelty detection service identifying new algal features in German waters, oil spill detection and forecasting services in French and Italian Waters, and HAB monitoring services for Norwegian Waters. Many of these services combine data from multiple providers, e.g. overlaying in situ ferrybox data from Norwegian Institute for Water Research (NIVA) on remote sensing data from NERSC, ferrybox data from GKSS Forschungszentrum Geesthacht (GKSS) overlaid on remote sensing data from PML, or predictions of oil drift overlaid on the SAR image used to identify the spill. These examples illustrate how cross-country and regional services can also be set up in the InterRisk SSE portal. In an operational service, more products will of course be needed and updates must be done in near-real time, but the mechanisms for making all products available and displaying selected layers in a web-GIS viewer are in place.

3.4 A complex service for chlorophyll-a thresholding

InterRisk is also developing complex services where users can perform several operations, such search for data, download data, run algorithms or models on the downloaded data. The result is a processed data set produced by the user based on his choice of input data and what processing steps he needs. The first complex service for thresholding chlorophyll-a data has been integrated in the InterRisk SSE (Figure 6). The user selects the date of interest and gives the threshold value. The complex service then processes the original chlorophyll-a data and produces a classified map.

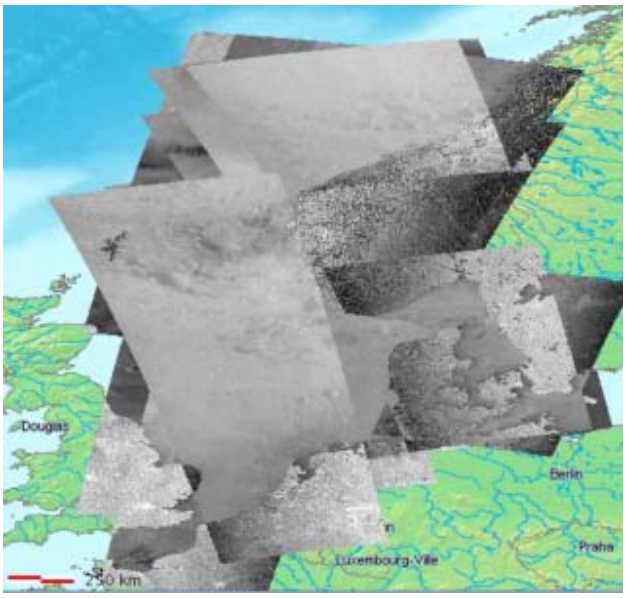

Figure 5. SAR oil spill monitoring in the North Sea area as example of InterRisk SSE service.

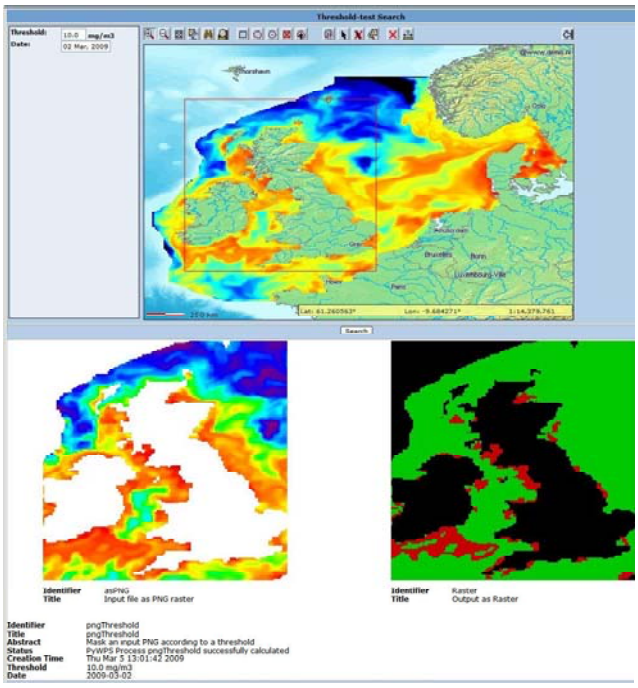

Figure 6. Example of a complex service in the InterRisk SSE.

4. SUMMARY AND CONCLUSION

The InterRisk project has established national portals for HAB and oil spill monitoring and forecasting, and currently demonstrates these to selected end-users in the target areas. Service providers' experiences are generally positive: Standardised tools are available for setting up services and portals, and once OGC compliant nodes are in operation they can provide products to multiple portals with no extra effort on the provider's side. Feedback from end-users will be collected as the demonstrations run, and will be used to improve the services and portals.

The first examples of pan-European service using sample layers from the providers have been registered in the InterRisk SSE portal. These service need to be extended with more layers before e valuation by end-users can be conducted, but the first test shows that the InterRisk SSE portal is capable of offering pan-European datasets when such are registered in the portal.

InterRisk has also developed complex services, combining multiple simple services to generate a new product. This allows much larger flexibility, because the user is not dependent on pre-processed data sets. In a Decision Support System, it is important that users can find and download all relevant data sets from satellites, aircrafts, in situ sensors as well meteorological and oceanographic data and present the data sets in GIS for efficient analysis and assessment (Figure 7). The web-based system of complex services developed in InterRisk will be useful to integrate the needed data in case of oil spills or other crises events.

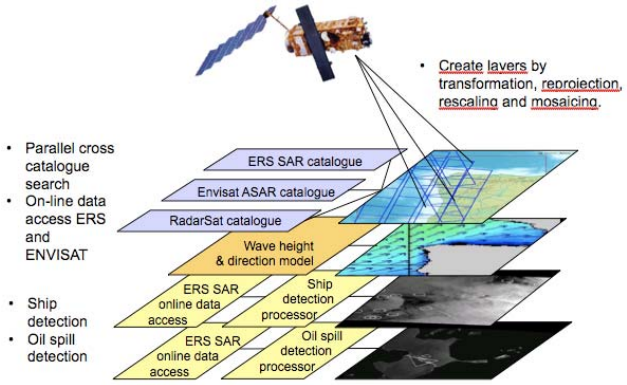

Figure 7. Illustration of how the SSE can be used to find data in catalogues, order and down load the data, retrieve derived products by use of accessible algorithms, and combine different data sets and processed geophysical variables in GIS layers.

References

ESA, 2004, Service Support Environment Architecture, Model and Standards White Paper.

Folkestad, A., L. H. Pettersson and D. Durand, 2007, Intercomparison of ocean colour data products during algal blooms in the Skagerrak, Int. Journal of Remote Sensing, Vol. 28, Nos. 3-4, pp 569-592.

IDT (INSPIRE Drafting Teams "Data Specifications", "Network Services", "Metadata"), 2007, INSPIRE Technical Architecture – Overview.

OGC, 2008, http://www.opengeospatial.org/standards

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