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SIMPLIFY REPORTING THROUGH SPATIAL DATA INFRASTRUCTURES - THE EXAMPLE OF THE GERMAN MARINE DATA INFRASTRUCTURE

Michael Bauer[1], Kirsten Binder[2] and Hans-Christian Reimers[3]

ABSTRACT

Many governmental agencies are charged with various reporting duties. Compiling, editing and forwarding data and metadata to comply with these is a tedious and time consuming task. In recent years, spatial data infrastructures (SDI) have been established as a means for interoperable data exchange. In the following the architecture of the German Marine Data Infrastructure is shown as an example on how to make use of a spatial data infrastructure to greatly decrease the workload. A series of independent infrastructure nodes, hosted by the data originators, provide the data and metadata that can be compiled into data reports while a central portal offers convenient access through the use of standardized data formats and interfaces.

1. INTRODUCTION

Governmental agencies collecting environmental data are subject to many reporting commitments. Especially in Europe there is a multitude of reporting duties to comply to. For example, in 2008 the European Marine Strategy Framework Directive (MSFD) came into force which obliges Member States to maintain or to restore the good condition of the marine environment and to allow sustainable use of European sea regions. The first reports on the efforts to achieve this are due in October 2012 in electronic form on reporting sheets, cf. Directive 2008/56/EC (2008).

But also other directives and international conventions require data and metadata: INSPIRE (Spatial Infrastructure of Spatial Information in the European Community), WFD (Water Framework Directive), HD (Habitat Directive), UIG (Directive on Public Access to Environmental Information), HELCOM and OSPAR (Regional Conventions to protect the environment of the North East Atlantic and Baltic Sea) are only the most prominent. The federalistic structure of Germany leads to 11 different agencies or institutes which are thematically or geographically responsible for the marine environment, marine conservation and coastal engineering, cf. Reimers (2011).

In order to submit the reports in a homogenous manner, the data from various sources and themes has to be merged as well arrangements have to be made on structure and content. These agreements are strictly based on their European and international guidelines. Not only names and

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formats have to be defined, but also code lists, units and reference systems. For a unified visualization of the different datasets, signatures and class boundaries must be defined and applied to the distributed data.

After reviewing the requirements the concerned German agencies have decided to migrate the data flow from laborious reporting via excel sheets and analog file transfer to a spatial data infrastructure (SDI) – the German Marine Data Infrastructure (MDI-DE) and thus providing the data to report along with all the necessary metadata. SDIs can also be an elegant way of merging distributed datasets without altering the actual data, thus tackling several problems of the reporting workflow at once.

2. ARCHITECTURE

A SDI is composed of a decentralized network of data providing services. These services as well as the data therein are documented with metadata documents. As the main benefit of SDIs is interoperability, no good can come from limited data formats and interfaces. This is why SDIs rely heavily on open standards and the work of standardization groups like the International Organization for Standardization (ISO) and the Open Geospatial Consortium (OGC).

In case of the German Marine Data Infrastructure each partaking agency sets up a infrastructure node, see Figure 1, providing the data that is collect by that agency, cf. Rüh (2011), Kohlus (2011). The benefit of hosting the data locally versus centralized caching is that the control of the data stays in the hands of the originators and thus actualizations, quality and access control measures can be directly applied.

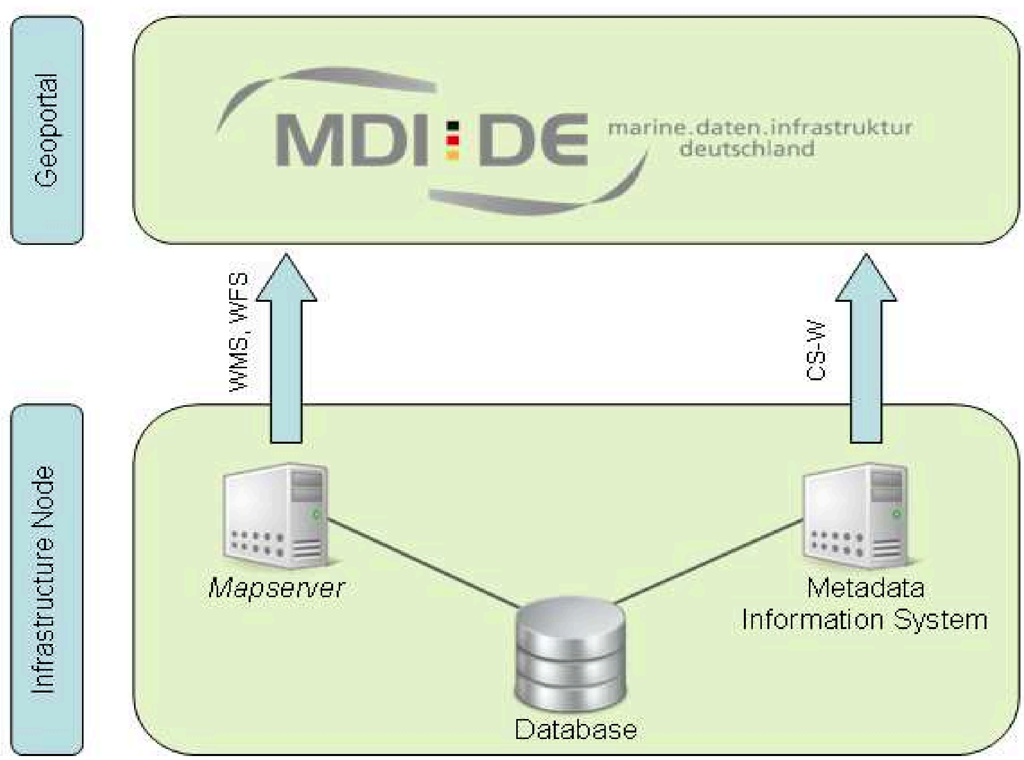

Figure 1 Generalized scheme of an Infrastructure Node of the German Marine Data Infrastructure.

For each institution which gets reported to, a custom-made composition of thematic data layers can be compiled without having to touch the data itself. To achieve such a seamless integration, each infrastructure node needs to be equipped with a few basic components: services to provide the data and metadata and a database to feed these two. For the provision of spatial data, the Open Geospatial Consortium (OGC) has developed a number of open and international standards. The most fitting in this context are the Web Map Service (WMS) to generate digital maps and the Web Feature Service (WFS) to download the data in an interoperable form. For both several open source implementations are available and easily set up. The underlying database needs to provide data to these services, which can be achieved by either installing a spatial database dedicated for this purpose or adding a data view to an existing database to adapt existing structures to the needs of the services. Thus ensuring the data distribution, the last piece of the puzzle is the corresponding metadata, which again is supplied by either a specialized database or a data view and distributed over the net by any metadata management tool which offers a standardized Catalogue Service for the Web (CS-W) interface, cf. Melles (2011).

Once several such nodes are up and running, an operator can compile thematic data sets by combining data from different sources. This can be made either with the geoportal[4] provided by the SDI (in our case www.mdi-de.org) or within any tool the operator feels comfortable with and supports established formats like GML (Geographic Markup Language) or ESRI Shapefiles.

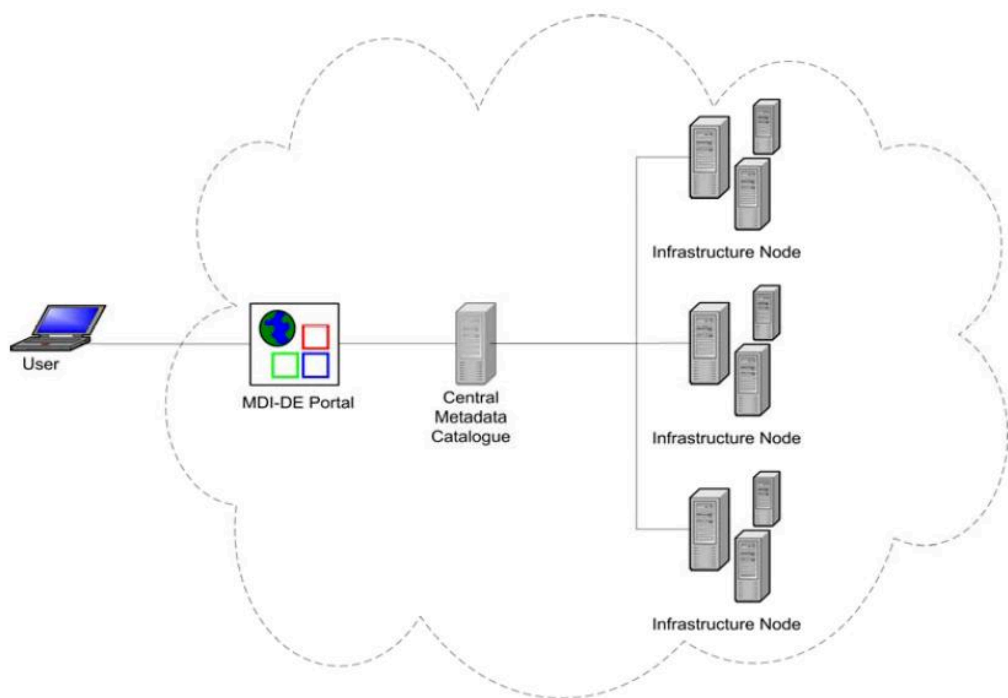

Figure 2 Schematic view on the MDI architecture.

The central geoportal of the German Marine Data Infrastructure provides a search engine and a map viewer as well as further information on the project. The search engine enables the user of the geoportal MDI-DE by searching in the Metadata Catalogues of the associated infrastructure nodes via the standardized CS-W interface. By means of an advanced search it is possible to search not only for keywords, but also for the type of a service or data sets as well as any other information in the metadata. The MDI-DE uses a metadata profile that is an expanded version of the ISO 19115

[4] http://www.mdi-de.org

standard and compatible with every metadata tool that support the ISO standard, cf. Wosniok (2012).

Found dataset can be displayed in the accompanying map viewer. There are also pre-compiled data sets on various topics available, such as economic use, protected areas or environmental parameters of marine areas. The map views are aggregated from the WMS of the distributed infrastructure nodes. The user has the possibility to add other topics, include external services or to load the services into her own desktop GIS.

3. USE CASE

Eutrophication is a good example of merging data from many distributed infrastructure nodes and is also one of the eleven different issues of the MSFD. Anthropogenic nutrient enrichment leads to increased occurrence of phytoplankton and fast-growing macroalgae. Other consequences are the decreasing clarity of the sea water, the decline of seagrass and perennial algae to the point of oxygen deficiency on the seabed. Many of these parameters are already measured at several agencies. In order to present reasonable data on a map, adjustments have to be made on time periods, units, labels, data aggregations and also class limits and signatures so the data becomes comparable.

The basis for the data structure of the WFS is an UML-model (Unified Modeling Language) which works within the regulations of INSPIRE and other standards, thus providing the public with environmental data and enabling the government agencies to fulfill the UIG without the need of further manpower to gather the needed data for each information request and then to send it via email or CD. This system of a spatial infrastructure with decentralized provision of multiple purpose services seems to be optimal for the fulfillment of European and international guidelines.

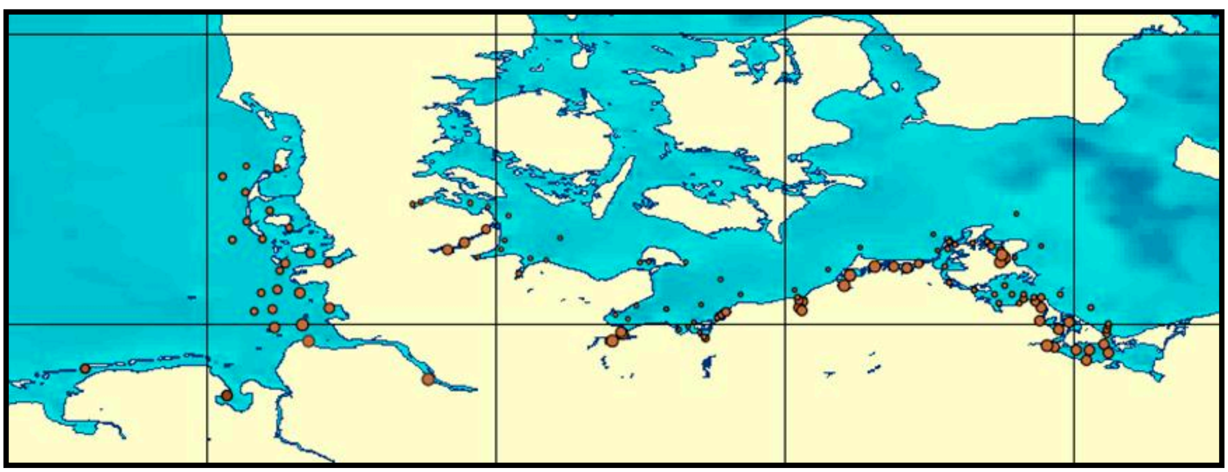

Figure 3 Total nitrogen concentrations in marine areas of four German agencies in the MDI-DE-portal[5]

The MSFD asks all European member states not only to report an initial assessment, a determination of the good environmental status and an establishment of environmental targets but also the corresponding data and metadata. The in the context of monitoring programs collected data are not only basis for the MSFD but also for reporting to other international conventions. According

[5] Find the interactice map here: http://is.gd/jziVsQ

to different guidelines the data can be merged and valuated in several ways and viewed in the aspect of different time periods, cf. Reimers (2012).

4. SUMMARY

The utilization of a SDI can substantially simplify the reporting process using the same data and metadata for different purposes as shown above in the example of the German Marine Data Infrastructure. When a user can find datasets via metadata, request it from services and merge them into one map, all he needs to do then is to include a permalink to the map in his report instead of including some physical storage medium.

A lot of work is still to be done, especially in regards to accessibility and usability as well as the preprocessing of the data. In the further course of the MDI-DE project, approaches to automated data harmonization is one of the main research focuses.

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