6th International Conference on Hydroinformatics - Liong, Phoon & Babovic (eds)

INFORMATION INFRASTRUCTURE FOR ICZM TASKS

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In 2002, the European parliament and the council of the European Union (EU) formulated a recommendation concerning the implementation of Integrated Coastal Zone Management (ICZM) in Europe. This recommendation encourages a more global view on coastal regions in contrast to many R&D projects, which still keep sectoral views on coastal problems with regard to, e.g. coastal protection, tourism, or ecology. Commonly, distributed institutions maintain the necessary information for ICZM with incompatible data formats and different policies concerning the data distribution. We report on standards and tools to support ICZM tasks, which originate from the framework of the North Sea and Baltic Sea Coastal Information System NOKIS, and their enhancements to meet current EU requirements resulting from the European Water Framework Directive (WFD), put forward in 2000. We present the implementation of the international metadata standard ISO19115 with a coastal zone community profile and introduce a user-friendly metadata editor to handle this documentary information. Main focus is on web services provided by a central web portal. Commonly used visualization and analysis tools, which can directly access the distributed data, are key features of the central methods base to support efficient work flows.

BACKGROUND

The coastal zones of the world are the target area of many different uses. The fact that 1995 over 2.2 billion people accounting for 39% of the world's population lived within 100km from the coast [23] contributes to the conflict of interests. Corresponding numbers for the Baltic Sea drainage basin are 31% (26 million people) of the population living in 50km distance from the coast [22] and ??% (?? million people) for the North Sea region.

In 2002, the European Union released a recommendation concerning the implementation of Integrated Coastal Zone Management in Europe [5]. Its member states will report about the ICZM implementation progress in 2006. There is a request for an "adaptive management during a gradual process, which will facilitate adjustment as problems and knowledge develop. This implies the need for a sound scientific basis concerning the evolution of the coastal zone".

Even earlier, in 2000, the European Union published the directive, which is commonly known as the Water Framework Directive [4]. This directive formulates explicit dates for the completion of different tasks in the field of water monitoring, e.g. a functioning monitoring network has to be set up by the end of 2005.

In the field of coastal engineering, there also exists the need for retrieving and accessing resources from distributed sources within the framework of Integrated Coastal Zone Management ICZM. Most ICZM activities focus on putting forward strategies and developing action plans for coastal zone management tasks. Only few initiatives are concerned with the actual management of data, which are needed for taking decisions. Nearly all papers on ICZM, in general, mention the necessity to gather data, to optimize the data quality, to close data gaps, and to evolve means for information exchange [21].

Existing initiatives for sharing information often rely on centralized databases, which, in the long run, are not properly maintained and often cannot provide simple export formats for interested users. Additionally, these databases are often not backed by reliable metadata as stated in [17], which is necessary for finding relevant information in the first place and for using the retrieved data in a responsible way.

CONCEPTS OF DATASHARING IN PAST AND FUTURE

One of the most important problems in information infrastructures is the question of data storage. Until today, most data from measurements are stored in central database systems, which replicate locally generated data in order to provide it to interested stakeholders, scientists, and other institutions, as well as to permit the generation of monitoring reports to higher level institutions. An example for this kind of database is the German database MUDAB [1], which is hosted by the German Federal Maritime and Hydrographic Agency. It is a central repository for marine environmental data from different sources and covers a number of interdisciplinary topics.

An example of a distributed system is the network of the World Data Centers (WDC) [11], which was established in order to archive and distribute data collected from the observational programs of the 1957-1958 International Geophysical Year. In December 2003, this system consisted of 52 WDCs.

The North Sea and Baltic Sea Coastal Information System NOKIS [17] is a German meta-information system. Assuming that it raises the quality of data and metadata if the database is kept locally, so that every improvement optimizes the daily work, a system design was chosen, which leaves the metadata bases at the participating institutions and simply mirrors the metadata sets onto a central server on the web (http://nokis.baw.de). The system is operational since the end of 2002 with favorable responses from the coastal community .

In general, centralized systems provide better overall performance, since the requests do not have to be processed by wrappers before being executed. The disadvantages of such an approach are obvious: the fact, that the original data is being processed and afterwards sent to a central instance, causes data that may be out of date when update cycles are chosen too long.. There is also the experience, that the motivation to provide high quality data to central assembling points is generally low when there is no reverse advantage of the data exchange.

EXISTING PROJECTS AND INITIATIVES

Until today, many projects and initiatives dealing with information infrastructures in ICZM remain pilot projects. Very few publicly accessible systems provide metadata or even data about the coastal zone. There are a number of projects on European scope, which deal with information sharing/information infrastructure. A prominent example is COASTBASE [2], which calls itself "the Virtual European Coastal and Marine Data Warehouse" [16]. The concept of COASTBASE includes components for data retrieval, data access and data manipulation, controlled by security mechanisms. The pilot project ended in 2001, and only a few data sets can be found in the system.

The COASTBASE project is continued partially in the EUROSION project [6], with focus on policy recommendations on how to manage coastal erosion in Europe in the most sustainable way. One of the objectives of EUROSION is the implementation of a comprehensive data repository, containing all relevant facts for coastal erosion. This data repository is implemented as a GIS database. Additionally, a metadata repository is being build up, which makes use of both COASTBASE and NOKIS technology.

An interesting example of how to implement visualization and analysis methods related to databases can be found in the DESIMA [3] project. DESIMA aims "to support and facilitate coastal zone management applications through an improved access and integration of various data/information sources and tools". It uses a map server interface with the possibility to query the selected data sets and offers the possibility to interactively run a pollution model for the Mediterranean sea.

ICZM INFORMATION INFRASTRUCTURE IN GERMANY

Germany is subject to the recommendations of the European Council, which advises the member states to establish an ICZM framework [5]. This task is complicated by the federal structure of Germany, which leaves the responsibility for all coastal protection and spatial planning tasks to the federal states. Only recently, first efforts have been made towards a common ICZM concept of all federal states [10] [20].

NOKIS/NOKIS++

Based on the completed NOKIS project, a new project, NOKIS++ has been launched. While NOKIS exclusively dealt with metadata, NOKIS++ will concentrate on the integration of different data sources from participants all over the coast.

As reported in [17], a web based tool for the user-friendly generation of metadata has been developed, which is based on the powerful combination of Java and XML technology. Within this project it became clear, that there was the need for the establishment of an information infrastructure for different tasks in the coastal zone. Especially the requirements of the WFD and the task of planning coordinates measuring campaigns should be met with a new approach, combining different distributed data sources.

While the implementation of a metadata entry and retrieval system was already finished within NOKIS, user demands triggered the planning of a new project which aims at accessing the data controlled by metadata.

The European WFD defines monitoring tasks, which have to be performed on river basins. Especially in federal organized countries like Germany, this raises the problem of accessing data which is stored in different databases and data formats, and which lies in the responsibility of different federal states.

Coastal Zone Metadata Standard

The NOKIS project (2001-2004) established a common metadata standard for the coastal community. This standard is based on the IS 19115/19139 standards for metadata about geographic information released by the ISO [12], [14]. These standards are part of a suite of standards and technical recommendations dealing with geographic information. IS 19115 is regarded as the successor to the Content Standard for Digital Geospatial Metadata (CSDGM) of the US Federal Geographic Data Committee (FGDC) [8].

In order to generate qualified metadata for data from the coastal zone, it is necessary to include additional information about hydrographic and meteorological events and circumstances, which influence the quality and interpretation of the results, such as tidal information and information about wind and waves. To meet these requirements, the FGDC published a shoreline profile to enhance the possibilities of the CSDGM [7]. It was necessary to include similar metadata in NOKIS. For this purpose, the original shoreline profile was adapted and included in the NOKIS metadata standard. For the time being, this was implemented in the central NOKIS XML schema by the alteration of one and the addition of five new elements.

To allow the addition of further community profiles, it will be necessary to modularize the NOKIS schema, including a dynamic configuration of the editor interface. This will be part of the development in the new project NOKIS++.

Metadata Editor

To generate high-quality metadata according to a complex standard, it is necessary to develop tools that assist the user in his task. To meet the demands of the end users, the requirements for this tool were compiled by the NOKIS project group, consisting of personnel who will have to work with it.

The editor is a web based application, which is consequently build using Java und XML technology. Because of the complexity of the IS 19115 metadata standard, many parts of the application are being generated, using XSLT stylesheets. With this approach, it is possible to implement changes in the underlying metadata model in a quick and inexpensive way. These automatization reaches as far as generating the SQL commands dynamically from XML and XSLT (Figure 1).

The system is completely database independent, by means of data type mapping it is possible to adapt many industry-strength databases (tested for Informix, MSSQL, PostgreSQL) which meet some minimum requirements (Standard SQL, Transactions).

The application thus needs a server platform with a Servlet Container like Jakarta's Tomcat (> 4.0) and a connection to a supported database system. The system is almost completely OS independent, it will run on any platform with a Java VM >= 1.4.
The user interacts with the system via a standard web browser, which should have JavaScript enabled for user comfort, but all components are usable without it if this is necessary due to local security policies.

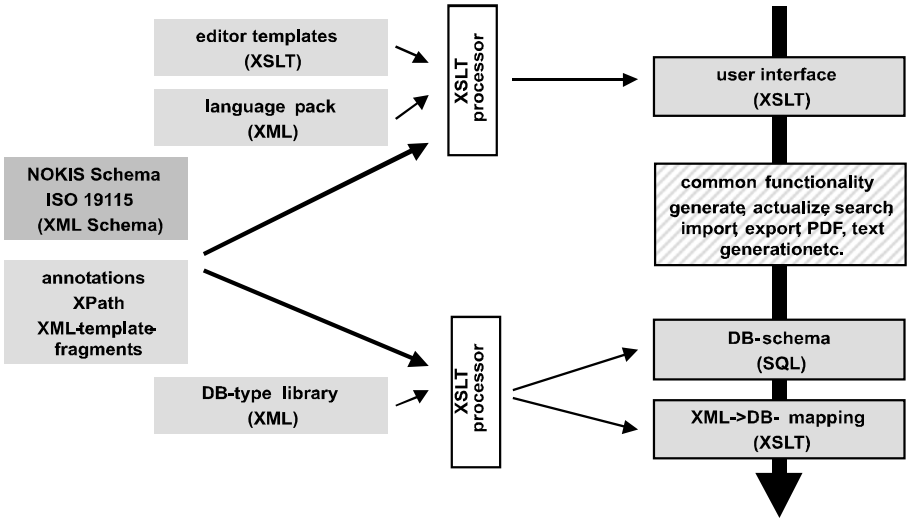

Figure 1: Functional Design of NOKIS

In the upcoming project NOKIS++ it is planned to further improve the software developed for NOKIS. One of the most important tasks is the improvement of the user interface, because the acceptance of the tool continually grew with changes in the user interface made in the project phase. In NOKIS, the editor interface was an exact representation of the underlying XML schema, not allowing any grouping of the elements by content principles. Within the EUROSION project, a technology was developed, which allows a placing of metadata elements according to user defined rules [15].

Because of the advantages and disadvantages of central databases, NOKIS++ will implement a distributed database architecture, which allows the participating institutions to maintain their own data and to control access to it. This concept will provide the user with a "virtual database", containing all data sources from the participating institutions to which he has access.

Web Services for ICZM

Based on a common data exchange format, which will make use of established standards, NOKIS++ will provide a number of different web services, allowing for visualization and analysis of data from the coastal zone, as shown in Fig. 2. Those data formats/services already exist for the exchange of GIS data. There is no commonly agreed standard for the exchange of data from time series or for modeling data, although there are efforts to establish a so-called Open Modeling Interface (OpenMI) by the project HARMONIT [9].

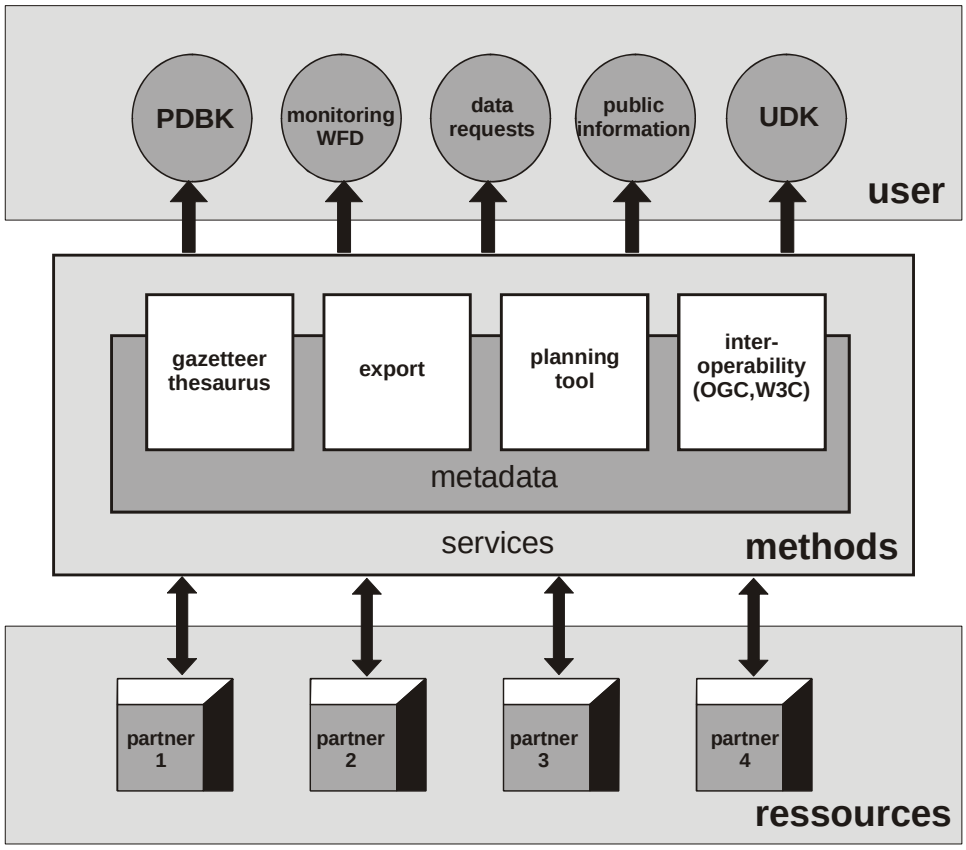

Figure 2: System Architecture for NOKIS++

The idea of NOKIS++ includes a web portal as a central component, which provides the platform for different services. These services will at least include a planning tool for coastal monitoring tasks, a report tool for the WFD, different export APIs and catalog services for the interaction with other data and metadata services.

The implementation will be based on a framework based on Java and XML, designed to allow the addition of new services/tools at any time without major changes on the

underlying system. All services running on the system will have to conform to current standards like IS 19119 [13] or OGC WFS/WMS/CS [18], [19].

Because the system should be as versatile and extendable as possible, the different services will use a common API, so further services can be easily added.

CONCLUSIONS

NOKIS shows how a successful metadata system can be established, making use of the motivation coming from the fact that the product facilitates the work of the persons in charge.

The monitoring and managing tasks within the European WFD show the need for the integration of up-to-date data from different and heterogeneous data sources.

A working metadata system which allows the retrieval of relevant data for the daily work immediately shows the need for a more comprehensive system that also allows the retrieval of the data itself.

There are already standardized means for the exchange of data (OGC, ISO), which apply mostly to the scope of GIS data. There are no commonly agreed data formats for exchanging data from time series or modeling data. This is a task that has to be faced in upcoming projects.

The use of web services for common tasks allows for a more efficient development and enables the shared use of tools in a widespread community.

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