Publishing and Distribution of Environmental Information in Civil Engineering Based on Spatial Metadata Description

Gerrit Seewald1, Michael Petersen2, Thomas Gutzke3

Abstract
This article introduces a new approach of managing and (pre-) processing spatial data in heterogeneous software and network environments. Within a joint research project between the Technical University of Darmstadt and the CIP Engineering Ltd. a prototype - covering the publishing, the internet-based distribution and the subsequent access to the relevant spatial and environmental information in civil engineering - has been developed. The description and management of the required information is implemented using an ISO 19115 conform data model. Due to the holistic approach of this standard a broad exchange of the collected Metadata across regional and national borders is guaranteed. Furthermore this structured data pool can be used as a meta-search engine for alpha-numerical, space- and time-dependent requests. As a result of these requests, access to the original data can be provided using a 2-tier service-oriented architecture (SOA) based on webservice technology.

1. Introduction
Environmental information based on geographical fundament play a more and more important role within civil engineering and its various phases of planning and construction. A survey from the BKG – Federal Office for Cartography has declared that more than 80 % of every activity or decision is based on geographic information (BKG 2002). Complex Inquiries and subsequent (post-) processes characterized by a high degree of time and cost expenditure are some of the negative consequences. The increasing technical developments within the hardware and network sector offer new possibilities for the overall distribution, collection the post-processing of geographic information in planning and construction processes of civil engineering.

1.1 Relevance of environmental information for the civil engineering sector
The usage of geo-references planning information reaches from orientation purposes within early planning steps up to specific project planning, e.g. the detail planning of waste landfills, embarkment dams or roadways. Within the last years geographic planning information are used for documentation purposes and the supervision of constructions. In this context a geographical logging of the location of various construction elements has been used for an effective documentation and defect management. These geo-information are of great importance in case of unexpected situations, e.g. if water pipelines or electric cables are damaged or if contaminations are discovered during excavations and underground engineering. In these cases efficiency and interoperability in information retrieval offer possibilities for a successful reduction of negative consequences for the investor, the planning partners and the construction companies.

1 CIP Ingenieurgesellschaft mbH, Robert-Bosch-Strasse 7, D-64293 Darmstadt, Germany
2 Fachgebiet Umweltinformatik, Fachhochschule Lippe und Höxter
3 Institute for Numerical Methods and Informatics in Civil Engineering, Darmstadt University of Technology, Germany
1.2 Usage of geo-information within planning processes

In contrast to the increasing importance of environmental geoinformation the planning partners in civil engineering have to scope with a variety of problems, which reach from the heterogeneous availability of geodata in the communal sector up to interface problems due to the different software systems. Furthermore, various aspects of IT security and responsibility have to be taken into account. The availability of digital environmental geo-information, especially in the communal sector, depends on the usage of geographical information systems (GIS). In Germany, this usage is addicted to the size of the cities: In a research project of Munich University of Technology in 2003 it has been shown that more than 90% of bigger urban communities (> 100,000 inhabitants) are using GIS, and the remaining 10% plan the implementation of these modern management methods. In contrast to this result there exists a statement, which claims that only 28% of the smaller cities and communities use GIS regularly and only 22% are planning its implementation (Schilcher 2003). Beneath the diverse penetration of the market in the field of GIS in the urban context the different, proprietary systems lead to severe interface problems regarding the exchange of environmental information. Despite the various initiatives for a harmonisation and standardisation no solution of the mentioned problems has been reached up to now. These problems are intensified with regard to the IT-security as well as the protection of data privacy and correctness (BSI 2003).

2. State of technique

According to the mentioned problems a variety of solution approaches have been developed for different fields. Metadata concepts, which are used for the harmonized specification and description of huge amounts of data, take an increasing role. „The information and documentation which makes data sets understandable and shareable for users.“ (ISO 2000–2004)

Comparable to the well-known register cards in libraries a harmonized description is used for a global provision and effective information retrieval performed by third parties.

2.1 Metadata standards

The field of metadata standards comprises a growing number of national and international initiatives for the standardisation of metadata descriptions. Widely-used are the FGDC-STD-001-1998 which has been adopted by the Federal Geographic Data Committee (FGDC) in 1998. In addition, another standard called ISO/TC211 19 115 has been created by the International Organization for Standardization (ISO) in 2004. Both approaches are characterized by various advantages and disadvantages which lead to the fact that a usage of one of these approaches has to be considered regarding the specific technical demands.

With regard to the exchange of environmental planning information in civil engineering the ISO 19 115 standard has been chosen in this project because of its higher degree of complexity, its possibilities for enhancements and its international orientation.

2.2 Metadata information systems

In order to improve and simplify the information retrieval various data-recall initiatives have been founded in recent years (q.v. table 1). Most of the well known information systems are based only partly on existing standards like ISO 19 115 and developed their own metadata descriptions for the enhancement of information retrieval.
In the context of civil engineering a lack of special requirements and adoptions for the usage of metadata in the planning processes can be ascertained within all existing information systems. Furthermore all systems are designed only for the information retrieval but not for an extensive direct data access to integrate the query results into concrete planning processes in civil engineering. The holistic data integration from the beginning of data retrieval up to the usage during the daily processes in civil engineering would be a great alleviation for all processes in civil engineering.

3. Service oriented Metadata information system

Within a research project between the Technology University of Darmstadt and the CIP Ltd. a service oriented Metadata information system for the holistic data entry, management data-recall, processing and multi-utilisation of environmental geo-information has been developed.

3.1 Process sequences

Based on the well known model of the service oriented architecture (SOA) a service oriented Metadata information system has been designed by combining web services with a centralized metadata- and an e-business-component. By this means the entire process of data handling - from data entry to data processing - can be efficiently supported. The complete process sequence consists of eight single sub-processes which are shown in figure 1.
1. registration/login
2. preparation/pre-processing user-defined environmental geodata
3. submission of metadata and automatic webservice generation
4. data retrieval
5. examination of search result and selection of data for further processing
6. direct access to the original distributed stored data and accounting transaction to the e-business platform
7. usage of the specific information within the existing planning process
8. accounting/payment

The presented system layout contains an integrated security mechanism for the protection of the original data and the simultaneous overcoming of technical network barriers through a highly configurable pre-selection and pre-processing system. During this pre-selection process either database stored or file-based geodata can be selected and composed as pre-release on an internet connected computer.

3.2 Webservice generation and submission of metadata

Subsequent to the pre-selection occurs the actual metadata description of the selected original data based on a custom-built community-profile of the ISO 19115 for the description of environmental geodata in civil engineering. The current community-profile consists out of 50 database tables and contains around 100 core data descriptors of the ISO 19115 standard (q.v. figure 2).
Beside the common fields defined in ISO 19115 like identification, responsibility, spatial and temporal extension and the quality of data, the description of online resources, formats and digital availability was adjusted to the demands of SOA and the information exchange via web services. Combined with an automated webservice generator the described service oriented metadata system provides the locating of environmental data as well as a direct access to the original database or file stored information.

The submission of metadata is performed semi-automatically during the webservice generation as far as the needed information can be derived from the original geodata. Following the generation, metadata and webservice information are published on a central metadata information system which provides an internet based search platform combined with an automatic webservice consumer front-end.

4. Conclusion

This contribution presented a holistic metadata system for the preparation, the publication, management and the following processing of original data. Based on existing metadata standards in combination with webservice technology an extensive system for the enhancement of environmental planning processes in civil engineering has been developed.
Bibliography

BKG (2002): BKG – Bundesamt für Kartografie und Geodäsie, in: Geoinformationen und moderner Staat, Frankfurt am Main, Germany


