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STANDARDIZATION OF GEOGRAPHIC DATA: THE EUROPEAN INSPIRE DIRECTIVE

Gabor BARTHA
University of Miskolc, H3515 Miskolc-Egyetemvaros, Hungary.
W3adm@uni-miskolc.hu , *iitgabor@uni-miskolc.hu*

Sandor KOCSIS
University of Miskolc, H3515 Miskolc-Egyetemvaros, Hungary.
W3adm@uni-miskolc.hu , *Alexander.kocsis@yahoo.com*

Abstract

The global geo-observation systems in the last decades have produced tremendous number of spatially dependant data sets claiming connections to a standardized *Spatial Data Infrastructure* defined as the technologies, policies, and people necessary to promote sharing of geospatial data throughout all levels of government, the private and non-profit sectors, and the academic communities. The legal and technical response of the European Union to this request is the INSPIRE Directive (Infrastructure for Spatial Information in the European Community - 2007/2/EC). The Directive ensures the compatibility with adaptation of common Implementing Rules (IR) in specific areas as Metadata, Data Specifications, Network Services, Data and Service Sharing, Monitoring and Reporting. This paper provides an overview of the Directive, IRs and the technical support of their implementation illustrated with some examples. It concludes with some important issues for European geography to consider and address.

Keywords: *spatial data infrastructure, INSPIRE, metadata, ISO 1900 standards*

1. INTRODUCTION

Spatial information data relating to local, regional or global scales are the basis of geography. Due to the recent developments in space technology the emphasis has been shifted to global data which are available for everybody in unbelievable abundance. Only the modern means of information technology and the task sharing could help to handle the large quantity of data. Obviously it generated a need for a unified and standardized Spatial Data Structure (SDI). The aim of SDI was clear (Dutch national stimulation program on SDI, 2010): 1) to share data evaluation and eliminate duplicated efforts in data evaluation; 2) to make geographic data worldwide easily accessible; 3) to support seamless integration of geographic data from different sources.

The US Geographic Data Committee was one of the first bodies that has been legally mandated to set up a national Spatial Data Infrastructure (Executive Order 12906, 1994 p.1) which contains the following definitions of SDI:

(a) ‘‘National Spatial Data Infrastructure’’ (‘‘NSDI’’) means the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data.

(b) ‘‘Geospatial data’’ means information that identifies the geographic location and characteristics of natural or constructed features and boundaries on the earth. This information may be derived from, among other things, remote sensing, mapping, and surveying technologies. Statistical data may be included in this definition at the discretion of the collecting agency.

(c) The ‘‘National Geospatial Data Clearinghouse’’ means a distributed network of geospatial data producers, managers, and users linked electronically

Throughout Europe there have been a number of national and regional initiatives to establish Spatial Data Infrastructures, most of them are driven by public administration or by public-private partnerships (Masser, 2007). Prominent examples include:

- Nomenclature des unités territoriales statistiques (NUTS)
- Arrangements on European Map Projections
- Draft Arrangements on an European Vertical Reference Systems
- Draft Arrangements on an European Reference Grid
- IMAGE 2000 and CORINE Landcover 2000
- European Soil Atlas
- EuroBoundaryMap
- EuroRegionalMap

Unfortunately, spatial information in Europe can be described as fragmentations of datasets and sources, with gaps in availability, lack of interoperability or harmonization between datasets at different geographical scales and duplication of information collection. Therefore SDI initiatives in Europe lacked a coherent, Europe wide framework on for instance which standards should be used, how to formulate data sharing policies, and more important which general feature models (i.e. for example attribute names, common spatial reference models, etc.) to follow. The multilingual nature of the European Union increases further this complexity. However, awareness has grown at national and at EU level about the need for quality geo-referenced information to support our understanding of the complexity and interactions between human activities and environmental pressures and impacts. Initiatives to establish a European Spatial Data Infrastructure are therefore timely and relevant but do also face major challenges given the general situation outlined above and the many stakeholder interests to be addressed.

Thanks to this awareness, in September 2001 an E-ESDI Expert group, representing geoinformation experts of the European Commission, the European Environmental Agency, and Member States’ environmental and national mapping bodies started the elaboration of a proposal for a European directive to establish an European Spatial Data Infrastructure (ESDI). The adoption of the proposal for a directive on establishing an Infrastructure for *Spatial Information in the European Community* (INSPIRE) by the European Commission in July 2004 marked the first important step on the way to a European-wide legislative framework to achieve an European Spatial Data Infrastructure.

The first overview of an organizational and a process model for INSPIRE was elaborated in a preparatory phase (2005-06). Five drafting teams were nominated, each being mandated to draft implementation rules according to the following five components of INSPIRE:

- **Interoperability of Spatial Data Sets and Services** - enlisting 34 data topics that shall be made available in the final infrastructure (see later ISO 19100 series).
- **Metadata** - to allow the discovery and evaluation of INSPIRE relevant data sets and services in Europe (see later provision for Metadata).
- **Network Services -** to make it possible to discover, transform, view and download spatial data and to invoke spatial data and e-commerce services (see later provision for Network Services).
- **Data Sharing** - to allow an ‘as easy as possible’ data exchange between public bodies and to allow third parties, especially citizens to have an as much as possible free and easy access to spatial information covered by INSPIRE (see later provision for data policy).
- **Coordination and Complementary Measures** – to monitor the organizational and management aspects of the INSPIRE implementation.

The five components above are illustrated on Fig.1.

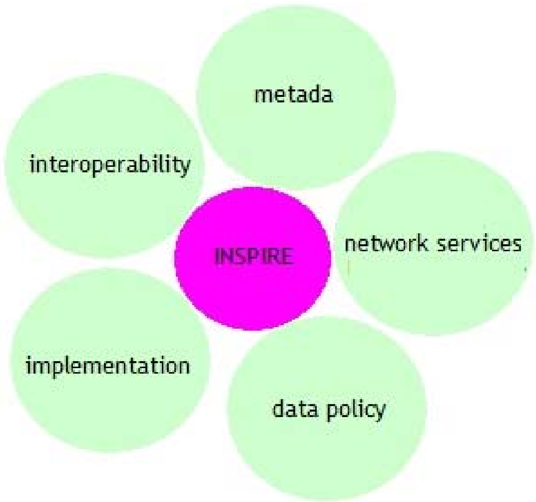

Fig.1 The five components of INSPIRE

In March 2007 the INSPIRE proposal was adopted as Directive 2007/2/EC of the European Parliament and of the Council, the Directive was published in the official Journal on the 25th April 2007. The INSPIRE work programm was updated to address the INSPIRE transposition phase (2007-09). The overall implementation was planned to take more than 10 years, thus by 2019 INSPIRE can be expected to be fully implemented. The shortest implementation time frame is given for the provision of metadata, with first parts to be implemented in 2010, followed by the Network Services being operational (~2011) and then by having a full set of Implementing Rules for INSPIRE Data Specifications (~ up to 2012) and their full implementation (~ up to 2019). The full roadmap of INSPIRE is depicted on Fig.2.

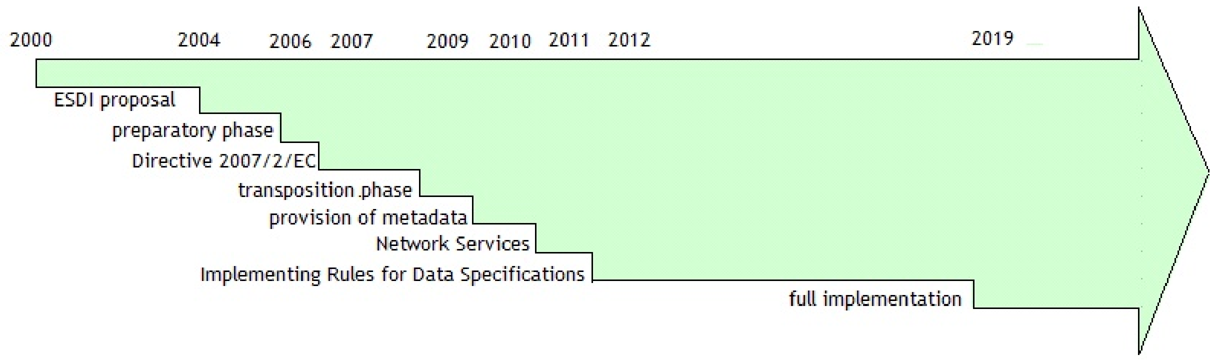

Fig.2 Roadmap of INSPIRE

2. ISO 19100 SERIES – THE TECHNICAL GROUND

The standardization process usually has three levels in EU Member State. The standards are established at international level, then adopted in European level and finally implemented national level. The structure of this process is shown in Fig. 3.

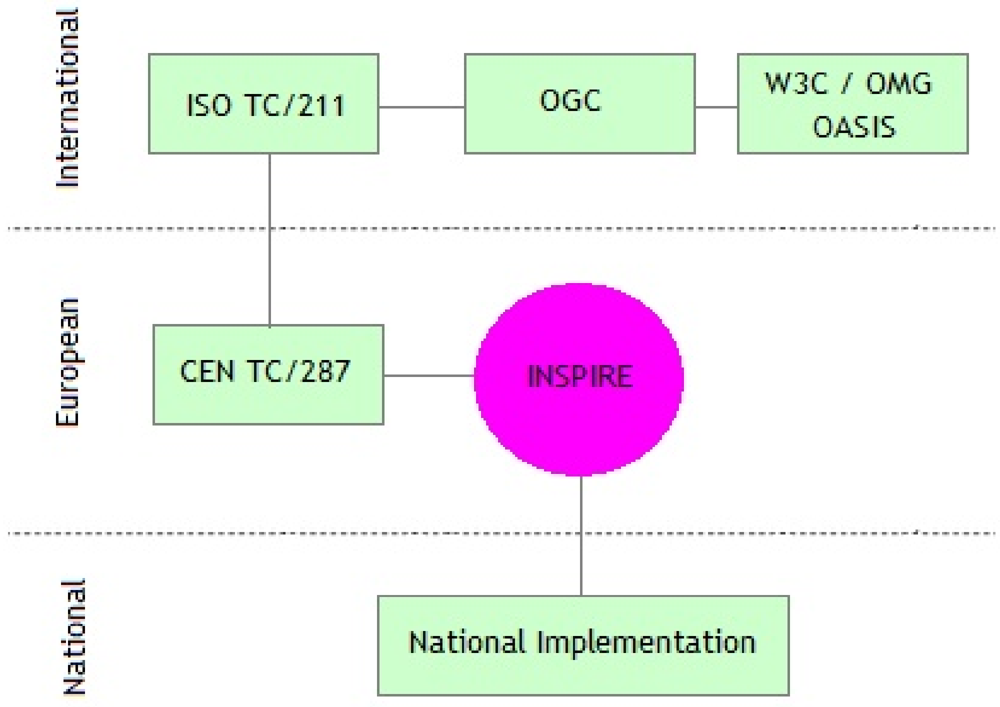

Fig.3 The structure of standardization process

In the case of INSPIRE the ISO 19100 series was selected as international standard for the technical base. The standards are summarized in Table 1. This series has been elaborated by ISO Technical Committee (TC) 211 as Geographic information/Geomatics standard based on the proposals of Open Geospatial Consortium (OGC) , World Wide Web Consortium (W3C), Object Management Group (OMG), Organization for the Advancement of

Structured Information Standards (OASIS) (ISO/TC 211 Advisory Group on Outreach, 2009). The standardization has been started at 2001 and still is in process.

Table 1. ISO 19100 series of standards
from ISO 19100 SERIES OF GEOGRAPHIC INFORMATION STANDARDS p. 9
www.wmo.int/pages/prog/.../5(2)_ISO.doc

6709 - Standard representation of latitude, longitude and altitude for geographic point locations	19122 - Qualifications and Certification of personnel
19101 - Reference model	19123 - Schema for coverage geometry and functions
19101-2 - Reference model - Part 2: Imagery	19124 - Imagery and gridded data components
19103 - Conceptual schema language	19125-1 - Simple feature access - Part 1: Common architecture
19104 - Terminology Introduction	19125-2 - Simple feature access - Part 2: SQL option
19105 - Conformance and testing	19126 - Profile - FACC Data Dictionary
19106 - Profiles	19127 - Geodetic codes and parameters
19107 - Spatial schema	19128 - Web Map server interface
19108 - Temporal schema	19129 - Imagery, gridded and coverage data framework
19109 - Rules for applicaiton schema	19130 - Sensor and data models for imagery and gridded data
19110 - Methodology for feature cataloguing	19131 - Data product specifications
19111 - Spatial referencing by coordinates	19132 - Location based services possible standards
19112 - Spatial referencing by geographic identifiers	19133 - Location based services tracking and navigation
19113 - Quality principles	19134 - Multimodal location based services for routing and navigation
19114 - Quality evaluation procedures	19135 - Procedures for registration of geographical information items
19115 - Metadata	19136 - Geography Markup Language
19115-2 - Metadata - Part 2: Extensions for imagery and gridded data	19137 - Generally used profiles of the spatial schema and of similar important other schemas
19116 - Positioning services	19138 - Data quality measures
19117 - Portrayal	19139 - Metadata - Implementation specification
19118 - Encoding	19140 - Technical amendment to the ISO 191** Geographic information series of standards for harmonization and enhancements
19119 - Services	
19120 - Functional standards	
19121 – Imagery and gridded data	

The standards specify the IT and the geographic aspects of Spatial Data Infrastructure and fall into five categories:

- Standards that specify the infrastructure for geospatial standardization.
- Standards that describe data models for geographic information.
- Standards for geographic information management.
- Standards for geographic information services.

- Standards for encoding of geographic information.
- Standard for specific thematics.

The ISO 19100 series of standards was adopted as the technical base for INSPIRE by the European standardization organization Comité Européen Normalisation - CEN TC/211. Their implementation included 34 themes. The themes are subdivided into three groups and included into the INSPIRE directive in three appendices. Member States should make the metadata available for the themes in Appendices I and II in 2010, and for the themes in Appendix III in 2013:

<u>Appendix I</u>

1. Reference systems using coordinates
2. Geographical grid system
3. Geographical names
4. Administrative units
5. Addresses
6. Land Registry plots
7. Transport networks
8. Hydrography
9. Protected areas

<u>Appendix II</u>

1. Height
2. Soil use
3. Ortho-image production
4. Geology

<u>Appendix III</u>

1. Statistical units
2. Buildings
3. Soil
4. Land use
5. Human health and safety
6. Utilities and public sector services
7. Environmental protection services
8. Facilities for manufacture and industry
9. Facilities agriculture and aquaculture
10. Population distribution — demography
11. Area management, areas where limitations apply, regulated areas and reporting units
12. Areas with risks to the natural environment
13. Atmospheric conditions
14. Meteorological and geographic characteristics
15. Oceanographic, geographic characteristics
16. Maritime regions
17. Bio-geographic areas
18. Habitats and biotopes
19. Distribution of species
20. Energy sources
21. Mineral sources

2. PROVISION FOR METADATA - THE FIRST STEP OF IMPLEMENTATION

Spatial information in Europe has no harmonization between datasets at different geographical scales and there are several duplications in the information collections as it has been pointed out before. What is worse, there is no clear picture on the obstacles. Therefore the first step is to establish standardized metadata system i.e. to make data about data. Metadata describe geographic datasets that search commands can focus on questions such as 'who, what, where, when, why and how'. Metadata contains details about the owner of the geographic data, quality, validity, etc., and how it can be traced and used.

The ISO 19115 International Standards, summarized in Table 2., defines metadata elements, provides a schema and establishes a common set of metadata terminology, definitions, and extension procedures. This International Standard defines the schema required for describing geographic information and services. It provides information about the identification, the extent, the quality, the spatial and temporal schema, spatial reference, and distribution of digital geographic data. This International Standard is accomplished with two other ones, namely ISO 19118 and ISO/TS 19139 concerning metadata encoding. ISO 19118 describes the requirements for creating encoding rules based on Unified Modeling Language (UML) schemas while ISO/Technical Specification 19139 defines Extensible Markup Language (XML) as selected encoding language for geographic metadata.

INSPIRE adopted these standards and recognizing the importance of metadata put forward their implementation plan (c.f. Roadmap of INSPIRE on Fig.2). The European Commission established a web site INSPIRE-Geoportal (www.inspire-geoportal.eu) to promote this process The opening page of this portal is shown on Fig.4. The site has four functional modules to help editing, finding and using European metadata.

- Metadata Editor module is an online editor for creating metadata xml files;
- Metadata Validator module validates ready metadata files;
- Discovery module to locate metadata files via a graphic interface;
- Viewer module to display/edit maps from digital data pointed out by metadata.

The use or implement of the functional modules is rather simple and straightforward. Detailed descriptions can be found in Technical Guides (Grasso,Craglia, 2010),(NSDT,2009), (IOCTFNS,2011). They can be downloaded from the portal.

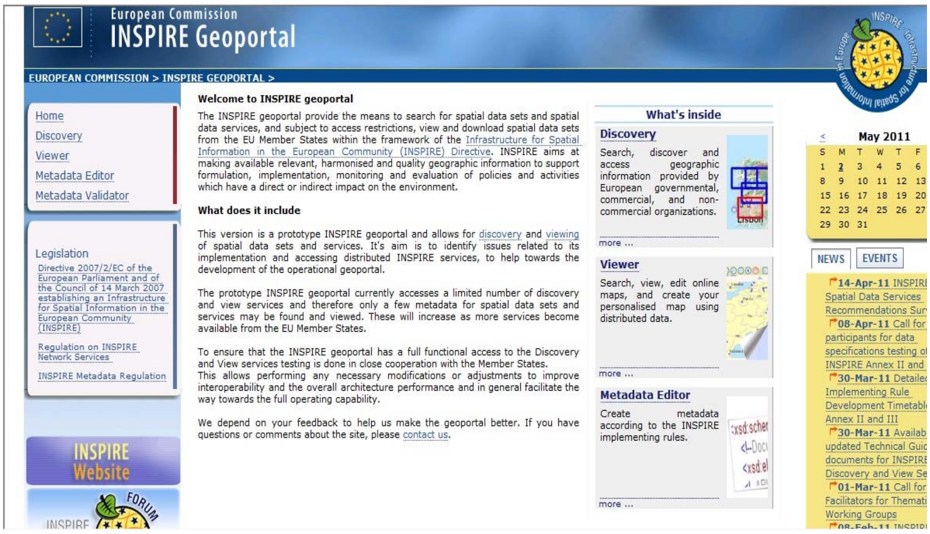

Fig.4 European Geoportal web site: opening page from: http://www.inspire-geoportal.eu

Besides the INSPIRE-Geoportal, the community of geologists are also preparing an Internet based metadata searcher, editor service called MICKA (one.geology.cz/metadata) tailored for geology in the framework of an international project, OneGeology Europe.

Dataset title (M) (MD_Metadata > MD_DataIdentification.citation > CI_Citation.title)	**Spatial representation type** (O) (MD_Metadata > MD_DataIdentification.spatialRepresentationType)
Dataset reference date (M) (MD_Metadata > MD_DataIdentification.citation > CI_Citation.date)	**Reference system** (O) (MD_Metadata > MD_ReferenceSystem)
Dataset responsible party (O) (MD_Metadata > MD_DataIdentification.pointOfContact > CI_ResponsibleParty)	**Lineage** (O) (MD_Metadata > DQ_DataQuality.lineage > LI_Lineage)
Geographic location of the dataset (by four coordinates or by geographic identifier) (C) (MD_Metadata > MD_DataIdentification.extent > EX_Extent > EX_GeographicExtent > EX_GeographicBoundingBox or EX_GeographicDescription)	**On-line resource** (O) (MD_Metadata > MD_Distribution > MD_DigitalTransferOption.onLine > CI_OnlineResource)
Dataset language (M) (MD_Metadata > MD_DataIdentification.language)	**Metadata file identifier** (O) (MD_Metadata.fileIdentifier)
Dataset character set (C) (MD_Metadata > MD_DataIdentification.characterSet)	**Metadata standard name** (O) (MD_Metadata.metadataStandardName)
Dataset topic category (M) (MD_Metadata > MD_DataIdentification.topicCategory)	**Metadata standard version** (O) (MD_Metadata.metadataStandardVersion)
Spatial resolution of the dataset (O) (MD_Metadata > MD_DataIdentification.spatialResolution > MD_Resolution.equivalentScale or MD_Resolution.distance)	**Metadata language** (C) (MD_Metadata.language)
Abstract describing the dataset (M) (MD_Metadata > MD_DataIdentification.abstract)	**Metadata character set** (C) (MD_Metadata.characterSet)
Distribution format (O) (MD_Metadata > MD_Distribution > MD_Format.name and MD_Format.version)	**Metadata point of contact** (M) (MD_Metadata.contact > CI_ResponsibleParty)
Additional extent information for the dataset (vertical and temporal) (O) (MD_Metadata > MD_DataIdentification.extent > EX_Extent > EX_TemporalExtent or EX_VerticalExtent)	**Metadata date stamp** (M) (MD_Metadata.dateStamp)

Table 2. Core metadata for geographic datasets from: ISO/DIS 19115
https://www.seegrid.csiro.au/.../GeologicMetadata/19115_DIS200108

"M" indicates that the element is mandatory.
"O" indicates that the element is optional.
"C" indicates that the element is mandatory under certain conditions

3. NETWORK SERVICES: LINKING TOGETHER

The INSPIRE Directive aims to build upon infrastructures for spatial information established and operated by the Member States. As a result, Member States shall establish and operate a network of the following services for the spatial data sets and services for which metadata has been created in accordance with this Directive:

- Discovery services making it possible to search for spatial data sets and services on the basis of the content of the corresponding metadata and to display the content of the metadata;
- Viewing services making it possible, as a minimum, to display, navigate, zoom in/out, pan, or overlay viewable spatial data sets and to display legend information and any relevant content of metadata;
- Downloading services, enabling copies of spatial data sets, or parts of such sets, to be downloaded and, where practicable, accessed directly;
- Transformation services, enabling spatial data sets to be transformed with a view to achieving interoperability;
- Invoking services enable a user or client application to run them without requiring the availability of a GIS services allowing spatial data services to be invoked;
- Registry is in fact not a standard service, but obviously all INSPIRE based services should provide a kind of registry for the stored data.

Those services shall take into account relevant user requirements and shall be easy to use, available to the public and accessible via the Internet or any other appropriate means of telecommunication. The INSPIRE network services are depicted in Fig.5.

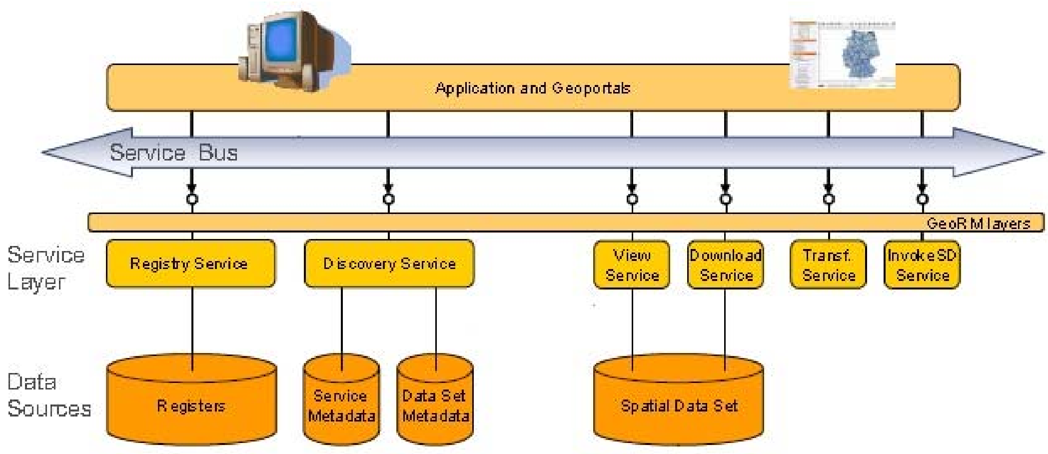

Fig.5 INSPIRE network services
from NSDT: INSPIRE Infrastructure for Spatial Information in Europe
http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/network/D3_5_INSPIRE_NS_Architecture_v3-0.pdf

INSPIRE networks are web based services therefore they use HTTP (HyperText Transfer Protocol). The data is structured according to the rules of UML (Unified Modeling Language). UML is a graphical planning frame to establish the structure of problem solving, or datasets, respectively. The data are described in XML (eXtensibel Markup Language). XML an object oriented, generalized markup language. The well known HTML (Hypertext Markup Languge) is a specialized form of XML. The objects are predefined in HTML, while in XML the developer is free to define any object. Therefore it is very convenient to describe datasets in a standardized form. The XML datasets are accessed in SOAP (Simple Object Access Protocol) frame. SOAP defines a simple and extensible XML messaging framework that can be used over multiple protocols with a variety of different programming models

(Villa at al, 2008). The defined framework is a higher-level application protocol that offer increased interoperability in distributed, heterogeneous environments.

The characteristic features of the INSPIRE network services and data management are summarized in Table 3. and Table 4., respectively.

Table 3. INSPIRE Network Services

Service	Description
Discovery	locating metadata files via graphic interface
View	displaying and edit maps
Download	supporting to download a part or complete datasets
Transformation	not completely clear yet, the goal is to support schema and coordinate transformation
Invoke	to enable a user or client application to run them without requiring the availability of a GIS
Registry	registry for data files is not a standardized but necessary part of service

Table 4. INSPIRE Data Management

Data	Associated Language/Frame
Structuring	UML (Unified Modeling Language) – graphic data structuring language
Description	XML (eXtensible Markup Language) – generalized object definition language for data description on Web
Access	SOAP (Simple Object Access Protocol) - messaging framework used over multiple protocols to access XML schemes

4. CONCLUDING REMARKS

There are both positive and negative conclusions to the INSPIRE Directive initiative and its implementation. Positively, the INSPIRE Directive is an important and necessary initiative to establish a unified standard for Spatial Data Infrastructure in Europe. The recognition of the importance of unified metadata for the fragmented European spatial data sets and to put forward in the implementation has been a crucial step to start INSPIRE. The central services (discovery, view, download, translation, invoke) and metadata editor and validator provide strong support to establish and use the metadata background for the European SDI. Several EU projects, publications help to implement and popularize INSPIRE. However from a negative perspective there remain big differences in the legal, technical and administrative treatment of spatial data among EU countries that will probably delay the implementation beyond expectations.

As concerning to geographers: they should elaborate their own metadata classes and metadata editors similar to the above mentioned MICKA for geologists. According to their experiences this work needs an international team working in a frame of a European project. The concept of INSPIRE Directive should be included in the geographical education probably in context with GIS. The connected teaching materials also should be elaborated parallel to the development of metadata editor.

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