

# INSPIRE

Fundamentals, Examples, Test Results



## Authors

M. Schilcher, Technische Universität München, Fachgebiet Geoinformationssysteme  
A. Fichtinger, Technische Universität München, Fachgebiet Geoinformationssysteme  
K. Jaenicke, Bavarian Information and Communication Technology Cluster, Munich  
V. Kraut, Technische Universität München, Fachgebiet Geoinformationssysteme  
J. Stahl, Technische Universität München, Fachgebiet Geoinformationssysteme  
F. Straub, Technische Universität München, Fachgebiet Geoinformationssysteme

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Editor:

Matthäus Schilcher

Runder Tisch Geoinformationssysteme e.V.  
c/o Technische Universität München  
Fachgebiet Geoinformationssysteme  
Arcisstr. 21  
80333 Munich, Germany  
Internet: <http://www.rundertischgis.de>  
E-Mail: [runder-tisch@bv.tum.de](mailto:runder-tisch@bv.tum.de)

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## Preface

Two years after its publication in 2007, the INSPIRE directive has entered implementation phase. The fourth, extended and updated edition of this brochure incorporates new developments and first experiences from tests with regard to the INSPIRE requirements.

The Runder Tisch GIS e.V. association publishes this brochure in order to provide information about the INSPIRE directive by presenting the fundamentals, selected examples and results of the INSPIRE-GMES-Testplattform (INSPIRE GMES testbed) project.

In addition to the current state of implementation in Germany, also Austria and Switzerland are taken into consideration. On the one hand, the brochure addresses decision makers from public administration, industry and science who have to adapt their IT and GIS strategies to INSPIRE requirements in due course. On the other hand, it provides information for employees of public authorities, GIS vendors and service providers who have to implement INSPIRE. Therefore, it incorporates experiences from the INSPIRE-GMES-Testplattform operated by Runder Tisch GIS e.V. as well as from other research projects carried out by Technische Universität München in the cross-border Lake Constance region (e.g. "HUMBOLDT" and "Semantic Data Model Transformation").

The idea for this brochure originated from a meeting of members of the Runder Tisch GIS e.V. association in 2007. It was developed in consultation with the SDI Competence Center Baden-Wuerttemberg ("GDI-Kompetenzzentrum Baden-Württemberg"), the SDI Office Bavaria ("Geschäftsstelle der Geodateninfrastruktur Bayern"), the Coordination Office GDI-DE ("Koordiniierungsstelle GDI-DE") as well as representatives of GIS industry. In doing so, a wide basis of information was created to be able to cover this topic in an unbiased way. The brochure is only published online, making it possible to incorporate current developments – e.g. concerning the implementing rules – more rapidly by issuing updated versions. For the present version, this applies e.g. to the Data Specifications. In addition to that, the GMES initiative and potential synergies with INSPIRE are more in focus. The combination of INSPIRE and GMES services is demonstrated using the INSPIRE-GMES-Plattform which is unique in its form. The brochure's next version will be published in March 2010 at the "15. Münchner Fortbildungsseminar Geoinformationssysteme" conference event.

I hope this brochure provides useful information for your work and look forward to your comments and suggestions.

Sincerely



Prof. Matthäus Schilcher,  
Chairman, Runder Tisch GIS e.V.

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## 1. Introduction to INSPIRE

The INSPIRE directive which came into force on 15 May 2007 aims at establishing an Infrastructure for Spatial Information in the European Community. It was initiated by the European Environment Agency with a view to facilitate the formulation, implementation and monitoring of environmental policies. Given the large variety of spatial data concerned, the directive also supports other policy areas. It will have far-reaching consequences for public authorities holding spatial data as well as the spatial information industry in general in the Member States of the European Union (EU).

The directive's 26 articles define a general framework for the European Spatial Data Infrastructure (ESDI). This is to facilitate that relevant spatial data sets of all levels of public administration within the EU can be easily discovered, shared between different authorities and combined in a consistent way across borders. The ESDI will be built on the spatial data infrastructures (SDI) established by the Member States. The national approaches to the provision of official spatial data and spatial data services are to be harmonised.

Technical details are specified in implementing rules e.g. on metadata, network services, interoperability of spatial data sets and services as well as data sharing. These are to be based on international standards e.g. of the Open Geospatial Consortium (OGC) or the International Organization for Standardization (ISO) as far as possible.

The directive covers a total of 34 spatial data themes, which are held in electronic format by or on behalf of public authorities and fall within the scope of their public tasks. Data sets which cannot be made publicly available due to existing privacy or copyright arrangements are excluded. The directive does not require the collection of new spatial data. Rather, it prescribes the way in which a public authority's existing or newly collected spatial data is to be provided. These data sets have to be made available in accordance with the implementing rules within fixed periods. Furthermore, spatial data sets and services must be described using metadata.

*„INSPIRE provides a crucial impetus to make available spatial information held by public authorities and to provide it to decision-makers from politics, business and public administration via spatial data infrastructures in a timely manner and in accordance with uniform standards.“*

Dr. Klement Aringer, Landesamt für Vermessung und Geoinformation Bayern



Access to spatial data sets listed in the directive shall be enabled using the following types of services:

- **Discovery services:** search for spatial data sets and services on the basis of metadata
- **View services:** displaying, navigating, zooming and overlaying spatial data sets
- **Download services:** download of and, where practicable, direct access to spatial data sets
- **Transformation services:** transformation of spatial data sets in order to achieve interoperability (e.g. data model or coordinate transformation)
- **Services** allowing spatial data services to be **invoked**.

Cross-border access to these services shall be possible via an INSPIRE geoportal. A fully operational version of the geoportal is expected for 2010. Currently, a prototype is accessible at [www.inspire-geoportal.eu](http://www.inspire-geoportal.eu).

While discovery services are to be provided free of charge, fees can be established for viewing or downloading data. In this case, e-commerce services have to be provided which ensure access according to terms of use or licenses. The provisions on data sharing between public authorities foresee, that public sector data providers can charge fees, in case they are obliged to achieve full or partial recovery of costs related to capturing, maintaining and providing spatial data and services within the scope of their tasks. However, „any charges applied should not exceed the cost of collection, production, reproduction and dissemination together with a reasonable return on investment.“<sup>1</sup> The directive doesn't contain specifications on fees for third parties.

The directive also stipulates measures for coordinating its implementation in the Member States, e.g. the establishment of national contact points.

*„Interoperable methods for protection and licensing of spatial data services will play an important role for the commercial development of INSPIRE services.“*

Christoph Uhlenkücken, con terra GmbH



<sup>1</sup> European Parliament and Council 2007

## 2. Key terms in the INSPIRE Context

### Spatial Data

INSPIRE defines spatial data as data with a direct (e.g. using coordinates) or indirect (e.g. using a postal code) reference to a specific location or geographical area.<sup>2</sup>

### Spatial Data Services

Spatial data services are software components made available on the internet providing functionalities for the usage of spatial data via software interfaces. Within a spatial data infrastructure, services complying with standards e.g. of the Open Geospatial Consortium (OGC) or the INSPIRE directive are needed for enabling interoperable access to spatial data. The terms geo services and geo web services are also often used synonymously.

### Spatial Data Infrastructure

A spatial data infrastructure (SDI) is characterized by the following, closely related components<sup>3</sup>:

- spatial data and associated metadata
- a technical infrastructure consisting of spatial data services, portals, user interfaces (clients), components for security, access control and billing as well as a network
- Standards enabling the interaction of the distributed, heterogeneous components within an SDI
- SDI stakeholders like providers and users of spatial data and spatial data services as well as operators of SDI portals
- a legal and organisational framework (legal provisions, agreements concerning access and use, mechanisms for coordination and monitoring)

### Interoperability

Interoperability denotes the ability of originally autonomous systems to co-operate. Via interfaces which are syntactically and semantically specified in an unambiguous way, services are provided to other systems and services of other systems are used. The complexity of the systems' internal structures is hidden from the user of a service.<sup>4</sup>

The INSPIRE directive adds a second focal point to the definition: In addition to the interoperability of services, it also requires the harmonisation of spatial data. Accordingly, interoperability means "the possibility for spatial data sets to be combined, and for services to interact, without repetitive manual intervention, in such a way that the result is coherent and the added value of the data sets and services is enhanced"<sup>5</sup>

### GMES

GMES (Global Monitoring for Environment and Security) is a joint initiative of the European Commission and the European Space Agency (ESA). It aims at generating European capacities for an independent and sustainable access to information on the environment and security. For this purpose, services based on the integration of space-based earth observation data as well as data from in-situ sensors are being set up.

### Metadata

INSPIRE defines metadata as "information describing spatial data sets and spatial data services and making it possible to discover, inventory and use them."<sup>6</sup>

### Meta-information Systems

Meta-information systems are integrated solutions for the acquisition, management, evaluation and provision of metadata. The provision of metadata through standard interfaces - in the case of INSPIRE through the so-called discovery services - is a crucial requirement for meta-information systems and also a key point in the context of the European Spatial Data Infrastructure. The OpenGIS Catalogue Service (CSW) Standard enables the interoperable usage of metadata via web services.

<sup>2</sup> European Parliament and Council 2007

<sup>3</sup> Jaenicke 2004 and Faust et al. 2009

<sup>4</sup> Donaubaer 2004

<sup>5</sup> European Parliament and Council 2007

<sup>6</sup> *ibid.*

### 3. Implementation and impact of the INSPIRE Directive

#### Roadmap for INSPIRE Implementation

The directive foresees a concrete, tight and binding roadmap for the realization of its goals (see figure 2). Two years after its entry into force - that is by mid March 2009 - the directive had to be transposed into the Member States' national law.

First of all, the implementing rules for metadata were published, which came into effect as a regulation on 24 December 2008<sup>7</sup>. The implementing rules for monitoring and reporting<sup>8</sup> followed in June 2009. By the end of 2009, the implementing rules for discovery and view services<sup>9</sup> as well as for data and service sharing<sup>10</sup> are to become effective. The implementing rules for download<sup>11</sup> and transformation<sup>12</sup> services are available as drafts. The data specifications for Annex I spatial data themes are available as second drafts and are to be finalised by the end of 2009.

In addition to the implementing rules, technical guidelines (e.g. on metadata<sup>13</sup>) are published, which refer to the standards relevant for implementation. These documents are not legally binding but if they are not taken into consideration, interoperability of data and services as postulated by the INSPIRE directive cannot be achieved.

2009 sees the beginning of the INSPIRE implementation and monitoring phase. Between 2010 and 2019, public authorities have to provide data and metadata listed in the directive step by step in an INSPIRE compliant way. The measures to be taken are addressed in the following sections. Please refer to the INSPIRE Work Programme<sup>14</sup> as well as the updated roadmap<sup>15</sup> for details concerning the INSPIRE timetable.

#### Responsibilities in Germany

In Germany, INSPIRE is implemented under the auspices of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety ("Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit", BMU). Since 2005, the BMU has headed an INSPIRE Task Force composed of experts from BMU, other federal agencies, states, municipalities, industry and science.

The steering committee GDI-DE („Lenkungs-gremium GDI-DE“) operates as Germany's

national contact point for the directive. It is composed of two federal representatives, one representative for the states and one for the municipal associations. This is laid down in an agreement between the federal and state administrations for building Germany's spatial data infrastructure ("Verwaltungsvereinbarung von Bund und Ländern zum Aufbau der Geodateninfrastruktur Deutschland")<sup>16</sup>. The coordination office GDI-DE ("Koordinierungsstelle GDI-DE"), jointly funded by the Federation and the states and organisationally attached to the Federal Agency for Cartography and Geodesy provides operational support to the steering committee. In addition, GDI contact points were established on state level, e.g. in Bavaria ("Geschäftsstelle Geodateninfrastruktur Bayern").

The national contact point is responsible for coordinating data and service provision as well as fulfilling monitoring and reporting obligations under INSPIRE. In the current phase, this also includes forwarding INSPIRE documents in comitology (e.g. draft implementing rules) to public authorities on all levels, collecting comments and passing them on to the European Commission<sup>17</sup>. Currently, representatives of German organisations are actively involved in the drafting of implementing rules (see Annex).

#### Transposition into German Law

The INSPIRE Directive has already been transposed into German law. In April 2008, a working group chaired by the BMU had submitted a draft spatial data access law ("Geodatenzugangsgesetz", GeoZG), which was adopted by the Bundestag in November 2008 and entered into force on 11 February 2009<sup>18</sup>. The working group included representatives of the BMU, the Federal Ministry of the Interior ("Bundesministerium des Innern") as well as of states and municipal associations. Given the federal structure of Germany, individual state laws (for the spatial data of states and municipalities) are needed in addition to the federal law (for the spatial data of the Federation). The federal GeoZG serves as exemplar for those.

Draft laws for the transposition of INSPIRE have been submitted in the majority of German states<sup>19</sup>. Bavaria was the first German state to introduce a spatial data infrastructure law ("Bayerisches Geodateninfrastrukturgesetz", BayGDIG)<sup>20</sup> which entered into force on 1 August

<sup>7</sup> European Commission 2008b

<sup>8</sup> European Commission 2009b

<sup>9</sup> European Commission 2009c

<sup>10</sup> European Commission 2009a

<sup>11</sup> Network Services Drafting Team 2009a

<sup>12</sup> Network Services Drafting Team 2009b

<sup>13</sup> European Commission Joint Research Centre 2009

<sup>14</sup> European Commission 2007b

<sup>15</sup> European Commission 2009d

<sup>16</sup> Bundesministerium des Inneren 2008

<sup>17</sup> Lenk 2008

<sup>18</sup> Bundestag 2009

<sup>19</sup> Koordinierungsstelle GDI-DE 2009

<sup>20</sup> Bayerischer Landtag 2008

2008. Other states in which those laws have also already become effective include Northrhine-Westfalia (GeoZG-NRW), Saxony-Anhalt (GDIG SAL), Thuringia (ThürGDIG) and Saarland (SGDIG).

In contrast to the INSPIRE directive itself, the implementing rules have direct legal effect in the Member States in case they are adopted as a regulation. EU regulations are binding for all administrative bodies in Germany ranging from the federal government to the municipalities.

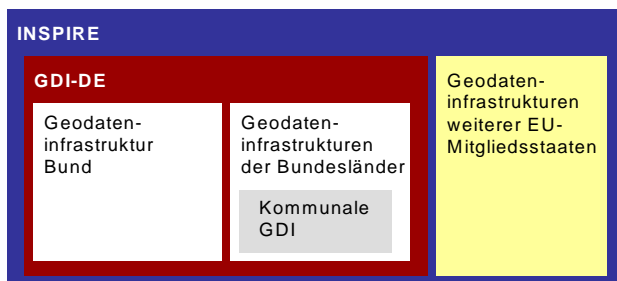
*"The obligation on EU Member States to transpose the INSPIRE directives into national law increases the importance of and the requirement for geospatial information at large."*

Dr. Gerhard Joos, Technical University of



### INSPIRE and GDI-DE

GDI-DE will form the national building block within the European SDI as defined by INSPIRE (see figure 1). The organisational and technical structures for building the GDI-DE are therefore already being aligned with the INSPIRE road map. The GDI-DE architecture concept<sup>21</sup> of August 2007 takes into consideration INSPIRE requirements. GDI-DE pilot projects such as Geodatenkatalog-DE (spatial data catalogue for providing metadata)<sup>22</sup>, address the technical implementation of INSPIRE in practice. The spatial data infrastructures of the German states



are established as integral parts of the GDI-DE<sup>23</sup>.

Figure 1: SDI hierarchy in Europe<sup>24</sup>

### INSPIRE Activities of GIS Vendors

In addition to public authorities, GIS vendors and other companies in the GIS industry are also active in the context of the INSPIRE directive. Their commitment ranges from customer information and consulting regarding the requirements of the directive to an active involvement in defining the implementing rules in the so-called INSPIRE Drafting Teams. Companies are taking INSPIRE into consideration during product development to ensure subsequent compliance.

*"Industry must be proactive and ready to provide systems and tools compliant with INSPIRE implementing rules immediately after their adoption."*

Alessandro Annoni, Joint Research Centre, INSPIRE Conference 2008



### Spatial Data Affected by the Directive

The INSPIRE directive primarily concerns spatial data held by public authorities. Thus the federal GeoZG e.g. applies to spatial data fulfilling the following conditions<sup>25</sup>:

1. They relate to the territory of the Federal Republic of Germany;
2. they are available in electronic format;
3. they are available at
  - a) a spatial data holding body falling within the scope of its public tasks and
    - aa) were produced by a body holding spatial data or
    - bb) were received by a body holding spatial data or
    - cc) are managed and updated by this body holding spatial data,
  - b) third parties which are granted access to the national spatial data infrastructure, or they are held on behalf of these.

In case multiple identical copies of the same spatial data set are held by various public authorities, only the reference version from which the copies are derived is concerned<sup>26</sup>.

The three annexes to the INSPIRE directive specify which types of spatial data are concerned (see annex A). This classification in three groups in annexes I to III also reflects a temporal prioritisation. Data specification work started with annex I data with respective drafts already being available.

<sup>21</sup> GKSt GDI-DE 2007

<sup>22</sup> GKSt GDI-DE 2008

<sup>23</sup> Faust et al. 2009 provide a comprehensive overview of the SDI Baden-Wuerttemberg

<sup>24</sup> GKSt GDI-DE 2007

<sup>25</sup> Bundestag 2009

<sup>26</sup> European Parliament and Council 2007

## INSPIRE Implementation in Austria

*Prof. Norbert Bartelme, TU Graz*



In Austria, the Federal Ministry of Agriculture, Forestry, Environment and Water Management („Bundesministerium für Land- u. Forstwirtschaft, Umwelt u. Wasserwirtschaft“), commonly known as „Lebensministerium“ is responsible for the national implementation of the INSPIRE directive. The department II/10 Invekos/GIS serves as national contact point for the implementation of INSPIRE.

A core team INSPIRE/AT was established. In addition to „Lebensministerium“, this core team comprises the Federal Ministries for Transport, Innovation and Technology („Verkehr, Innovation und Technologie“), Economy, Family and Youth („Wirtschaft, Familie und Jugend“), Interior („Inneres“) as well as Finance („Finanzen“). Furthermore it includes representatives from the Federal Office of Metrology and Surveying („Bundesamt für Eich- und Vermessungswesen“), the Federal Environmental Agency („Umweltbundesamt“), Statistics Austria („Statistik Austria“), the states, the Association of Austrian Cities and Towns („Städtebund“) and the Austrian Association of Municipalities („Gemeindebund“).

To begin, three sub-projects were defined by the core team:

- **Legal Transposition** (includes drafting a federal law on spatial data infrastructure as well as state laws based on this)
- **Metadata** (alignment with profil.at, the national metadata profile of ISO 19115)
- **Network Services** (the national position towards the overall architecture and the implementing rules for discovery and view services.)

The following principles serve as guidelines in Austria:

- Taking into consideration European and Austrian laws (e.g. for data protection)
- Consensual interpretation of the directive for all authorities concerned and open communication
- Establishing spatial data and services as part of the infrastructure of public administration
- Ensuring authenticity, availability, coverage, update and continuity
- Resource efficient implementation at all levels of the Austrian administration, integrating existing systems and processes as extensively as possible.
- Implementation not beyond immediate requirements in place (no "gold plating")
- Keeping the existing decentralized data storage through interoperable INSPIRE-compliant services
- No change of responsibilities for the creation, maintenance, provision and transfer of spatial data

In addition to the partly unclear and very ambitious EU requirements, the definition and delimitation of the spatial data affected, cost estimates and budgets as well as communicating the need for implementation are seen as the biggest challenges in Austria.

## INSPIRE Implementation in Switzerland

*Dr. sc. ETH Peter Staub, swisstopo*



The implementation of the INSPIRE directive is of great importance for Switzerland. Particularly in the environmental field, requirements of INSPIRE are in part directly implemented. Through the enactment of the spatial information law („Geoinformationsgesetz“, GeolG<sup>27</sup>) on July 1<sup>st</sup> 2008 Switzerland has a legal means to manage and develop projects to build the national spatial data infrastructure (NSDI). Principally, NSDI developments must not be in direct contradiction to the INSPIRE directive. An INSPIRE national point of contact has been established in order to monitor the INSPIRE implementation process actively and to enable a targeted coordination of efforts in Switzerland. This is of particular interest for two reasons: Firstly, the technical and organizational framework of the INSPIRE implementation is relevant also for the NSDI in Switzerland. Secondly, the subsequent integration of the Swiss NSDI into a future European SDI is enabled through appropriate interface standards. The Federal Office of Topography swisstopo („Bundesamt für Landestopografie swisstopo“) is participating in consultations as a legally mandated organisation. The steering body e-geo.ch for the establishment of the NSDI in Switzerland as well as the Swiss Organisation for Geographic Information („Schweizerische Organisation für Geo-Information“) contribute to the process of INSPIRE implementation as Spatial Data Interest Communities. In addition, Switzerland is directly represented in the drafting team Data Specifications. Through the participation in INSPIRE, synergies arise for Switzerland, and the long-standing experience in the field of data modelling promotes efforts in INSPIRE, respectively.

<sup>27</sup> Schweizerische Eidgenossenschaft 2007

## Data Providers Concerned by the Directive

INSPIRE first of all obliges the EU Member States to make data available in accordance with the directive's provisions. The Member States are responsible for making arrangements regarding data provision within each state (including the above-mentioned laws). The directive primarily concerns public administrations at all levels, i.e. federal, state and local authorities, which hold the above-mentioned data in electronic format. Thus also service providers which undertake GIS operations or spatial data management on behalf of these authorities are potentially concerned by INSPIRE. Spatial data existing at the lower levels of public administration and the municipalities are only covered by the directive, if their collection or dissemination is required by law. The coordinating office GDI-DE is currently carrying out a survey in cooperation with the SDI contact points of the German states in order to identify spatial data sets and their providers relevant for the spatial data themes listed in annex I of the directive<sup>28</sup>.

Costs incurred for the coordination of the INSPIRE implementation are split between the German Federation and the states according to the above-mentioned administrative agreement<sup>29</sup>.

## Consequences of the Directive for Data Providers Concerned

The directive requires the bodies holding spatial data - as defined in the spatial data themes - to provide these according to the implementing rules using appropriate services as well as to document data and services by means of standardised metadata.

The INSPIRE Data Specifications developed by the Thematic Working Groups contain requirements and recommendations e.g. concerning data content and structure, reference systems, data quality criteria, theme-specific metadata elements and portrayal. Harmonised, pan-European common conceptual data models for each of the data themes form the core of the Data Specifications. Object classes, attributes, data types, relations and constraints relevant for a data theme are described in UML<sup>30</sup> diagrams and corresponding feature catalogues<sup>31</sup>.

From a data provider's (e.g. mapping agency's) perspective this does not necessarily imply having to change the data models and data management of their original data. However, for the INSPIRE compliant provision of relevant data, a transformation of data from their original data models, such as the ATKIS Basis-DLM as part of the AFIS ALKIS ATKIS reference model (AAA) in Germany

into the data models specified by the EU is required<sup>32</sup>.

Summing up, the following steps have to be taken by a data provider concerned by the directive:

1. **Identifying** relevant spatial data sets
2. **Analysing** existing spatial data sets and corresponding metadata
3. Initial recording of INSPIRE-compliant **metadata** or preparation of existing metadata to be provided according to INSPIRE requirements
4. Preparing the INSPIRE-compliant delivery of **spatial data** (executing the required **data harmonisation steps** like data model or coordinate transformation)
5. Setting up **spatial data services** (organisationally and technically), to provide spatial data and metadata

The INSPIRE directive establishes binding deadlines within which the requirements have to be met. Figure 2 provides an overview of the timetable for the adoption of implementing rules and the provision of INSPIRE-compliant data and services. First delays have occurred, e.g. the Metadata Regulation having entered into force half a year later than originally planned. Accordingly, also the deadline for the provision of metadata for spatial data themes of annexes I and II is shifted by six months to the end of 2010.

Detailed, concrete action recommendations cannot be given until all implementing rules have been finalised and adopted. However, it has already become apparent, that the SDI defined by INSPIRE will be based on the concept of a Service Oriented Architecture (SOA) which is already established today. INSPIRE also includes requirements concerning the availability and response times for the various types of services. It is advisable to consider these aspects already today when it comes to decisions on IT and GIS infrastructure as well as restructuring of processes in public authorities.

<sup>28</sup> Koordinierungsstelle GDI-DE 2009

<sup>29</sup> Bundesministerium des Inneren 2008

<sup>30</sup> Unified Modeling Language, used for object-oriented modeling of systems and data

<sup>31</sup> Illert 2009

<sup>32</sup> This topic is at the core of a pilot project undertaken by Technische Universität München in cooperation with the Swiss Federal Institute of Technology Zurich since 2006, cf. Donaubauer et al. 2008

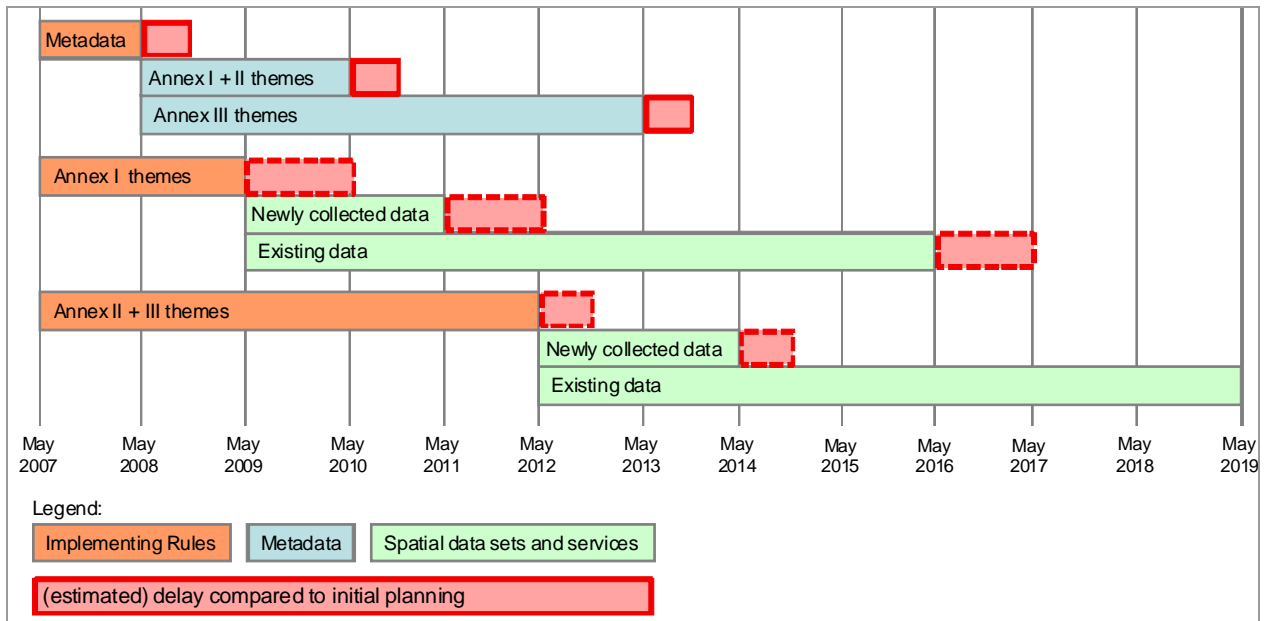


Figure 2: Roadmap for INSPIRE Implementation<sup>33</sup>

### The Directive's Potential for Users

The INSPIRE directive's key potential lies in the interoperability to be achieved. This will facilitate cross-institutional and cross-border access to spatial data and spatial data services. Building the European Spatial Data Infrastructure potentially holds great benefits for providers of INSPIRE compliant data and services as well as for their users and further groups within and beyond the

*"INSPIRE has a signalling effect on the spatial information market - its service-oriented approach provides the opportunity to finally implement a clear process orientation in the use of spatial information."*

Dr. Jens Hartmann, Intergraph Deutschland



spatial information sector.

### Federal, State and Local Public Authorities:

- Simplifying the fulfilment of reporting obligations under various environmental directives of the European Commission, e.g. the Directive on Environmental Noise (Directive 2002/49/EC), which requires the generation of noise maps.
- Activating the value-creation potential of spatial data and spatial data services, e.g. by marketing them as base for application specific data of public and private data providers.

- Simplified, standardised and browser-oriented access to distributed, heterogeneous spatial data and spatial data services using state-of-the-art technologies.
- Increasing cost-effectiveness of spatial data usage: reduced costs, e.g. if only one section of the dataset is needed and increased benefit e.g. through accessibility of spatial data which were previously unavailable or difficult to use.
- Simplified exchange of data between public authorities (e.g. within an inter-municipal cooperation or cross-border).
- Utilizing the INSPIRE approach (Service Oriented Architecture, avoiding redundancies, standardised interfaces, shift from GIS-centric to process view, etc.) for optimizing internal processes and integrating GIS into an organisation's IT environment.
- Advancement and legal safeguarding of federal, state and local SDI initiatives.

<sup>33</sup> based on Lenk 2008

### Companies Including Engineering Firms and Research Institutions

- Positioning as service providers supporting the implementation of the INSPIRE Directive.
- Placement of INSPIRE compliant products on the market, since the directive requires the adaptation of IT and GIS infrastructure as well as processes.
- Substantial simplification of access to distributed spatial data of public authorities by means of the central INSPIRE geoportal or the federal, state and local geoportals being established. This includes the potential of providing new products and services based on the data.

*"The (GIS) industry needs freely available and affordable data as well as access to the original data sets of data producers and data holders as open as possible."*

Richard Malits, rmDATA GmbH



### Citizens:

- Support for democratic opinion-forming processes by means of freely accessible public information.
- Increased transparency regarding the information base for decision-making in public administration.
- Simplified usage of official spatial data.

*"After Google Earth, INSPIRE will give now another new dynamism to spatial information, finally making accessible, after more than ten years of existence, high-tech GIS skills and products to the citizens."*

Michel Rosio, Stadtgemeinschaft Straßburg





GET READY FOR  
INSPIRE

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- ▶ Integration of GIS and ERP components (e.g. SAP R/3)

**Our solutions are based on international standards and guidelines, e.g. W3C, ISO, OGC, STANAG, INSPIRE.**



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APPLICATIONS

SOLUTIONS

## YOUR REQUEST

- You need a plan showing the current state of your property including a survey of the corresponding assets.
- Damage of traffic areas or buildings is to be measured for maintenance planning.
- You request a three-dimensional town model for town planning or for estimating ambient noise.
- For your marketing you need information about traffic and pedestrian flows, parking spaces and about the reachability by public transport.
- You are planning optimal locations for base stations to reach a maximum of mobile phone users at limited expense.
- You need to know the exact location of emergency access roads, hydrants, and gas supply lines as well as the number of persons to be evacuated.
- You require information about areas which are in danger of flooding and about appropriate sites for control measures.
- Green space and habitat registers and tree cadastre are to be used in the context of issues of environment protection and nature conservation.
- You wish to inform about hiking trails and cycle tracks, their level of difficulty, interesting destinations and halting places.

## WE OFFER

- Professional consulting regarding the selection and acquisition of geospatial reference data as a basis for geographic information systems
- Transformation of geospatial data from different graticules and formats to the required reference system and adjustment of the data to concrete requirements and scales
- Acquisition of other space-oriented data and factual information
- Consolidation of complete data in a GIS
- Modelling and updating of data
- Comprehensive analyses of geospatial data by means of geospatial operators and mathematic functions
- Visualisation of processed data and of the results of your request in a three-dimensional model, thematic map, diagram, table or as a presentation in a web-based geospatial portal
- Conceptions for customised geographic information systems including cost and operation planning
- Strategies for guaranteeing data compatibility and for using modern geospatial data infrastructures
- Further training opportunities in the field of geospatial data and geographic information systems

[www.bdvi.de](http://www.bdvi.de)



## 4. Synergies between INSPIRE and GMES

Dr. Wolfgang Steinborn (DLR)



GMES (Global Monitoring for Environment and Security) is the second European flagship in space technology application after the navigation system GALILEO. Mandated by the European Parliament (1999) and the European Council (2001) GMES will concentrate existing earth observation capacities in member states and reinforce these with European components for an independent assessment of the state of environment and security. Following the launch of first pre-operational services for land and marine observation and emergency management in 2008, full-fledged operation is to be achieved with the start of the next European financial perspective 2014. By then also services for air and atmospheric quality and services to improve internal and external security will be in the portfolio. So far, particularly the land service has already contributed to the creation of new European GI content on scales ranging from 1:50000 (land cover / land use in 38 European countries) to 1:10000 (European Urban Atlas): [www.land.eu](http://www.land.eu).

A frequently asked question is: we already have the INSPIRE directive - so why do we need GMES? The table provides the answer. Both initiatives are complementary, which is also emphasized in both, the directive as well as a draft EU Regulation on GMES. While INSPIRE provides for the "sharing" of existing spatial data (horizontal), GMES is an investment into additional European content, which also integrates existing data (vertical). INSPIRE can benefit from the experiences gained, especially when it comes to the specification of data and associated data models in Annexes II and III.

INSPIRE places no obligation on member states to create new geospatial data sets (where missing), whereas the objective of GMES is to ensure the continuous availability of observation data and services. In Article 10 of the Preamble, the INSPIRE directive therefore recommends the usage of GMES and Galileo to the member states. Of particular value is the monitoring character of GMES, which brings aspects of up-to-dateness and cross-border synopsis to European geo-information.

<b>INSPIRE</b>	<b>GMES</b>
Legal framework for data sharing	Investment for new European GI content
Building on existing technology (networking etc.)	Bringing innovative technology (data capture, geodynamic process modelling etc.) into operation
Existing data from member states	New data sources (adapted to cross-border and global problems)
Periodic updates	Continued monitoring
Data specification for interoperability and harmonized access services <b>(horizontal approach)</b>	Data integration for services <b>(vertical approach)</b>

## 5. INSPIRE and GMES Activities of the Runder Tisch GIS e.V.

### Information Hub

The Runder Tisch GIS e.V. has been concentrating on the INSPIRE topic since the year 2007. With this brochure the inform the institutions concerned and thus prepare them for the challenges of the INSPIRE implementation.

### Training courses, information events with GIS companies and data providers

INSPIRE is also taken up in training courses and information events. During the "Münchner Fortbildungsseminar Geoinformationssysteme" conference events in 2008 and 2009, the topics spatial data infrastructures, INSPIRE and GMES played a major role. Runder Tisch GIS e.V members can download the presentations from the association's website.

In addition to that, The Runder Tisch GIS e.V. offers training courses on SDI technology (e.g. "OGC standards for web services"). The courses "INSPIRE – fundamentals", "INSPIRE – services" and "INSPIRE – data harmonisation" deal with the directive and its effects. They are held by experts of INSPIRE-GMES-Plattform project partners. While the fundamentals course is aimed at decision makers and consultants, the technical courses are tailored to technical users and developers. In 2010 the association offers the possibility to get informed about INSPIRE by participating in training courses on March 8<sup>th</sup> and 9<sup>th</sup>, followed by the "15. Münchner Fortbildungsseminar" conference event on March 10<sup>th</sup> and 11<sup>th</sup>. For further information, please refer to [www.rundertischgis.de](http://www.rundertischgis.de).

### INSPIRE-GMES-Testplattform Project

23 members of the Runder Tisch GIS e.V. (see figure 4) have joined forces in this project to create a permanent environment for testing INSPIRE services. Project partners are members of INSPIRE and GMES industry as well as universities and public administration.

Existing know-how is exchanged and focused in order to ease the INSPIRE implementation and to improve the partners' competitiveness. The Runder Tisch GIS e.V. supports this project with initial funding.



Figure 3: INSPIRE-GMES-Testplattform project partners

The project serves as testbed for the provisions of the INSPIRE directive. Interoperability tests are required, since the ESDI will consist of a multitude of different, country-specific data sets, services and systems.

The project's core concept and expected benefits are illustrated by figure 4. It is not the goal to build an operational SDI but to provide a testbed. The complex environment of an SDI is simulated as realistically as possible using heterogeneous datasets and services. Important aspects are:

- usage of software of different vendors to be able to perform compatibility tests
- usage of data sets and services from different countries and different data providers in order to illustrate problems with heterogeneous data models in a cross-border context

In addition to testing interoperability and clarifying questions about the correct interpretations of the directive, further research is needed when it comes to transforming existing data to match the INSPIRE data models.

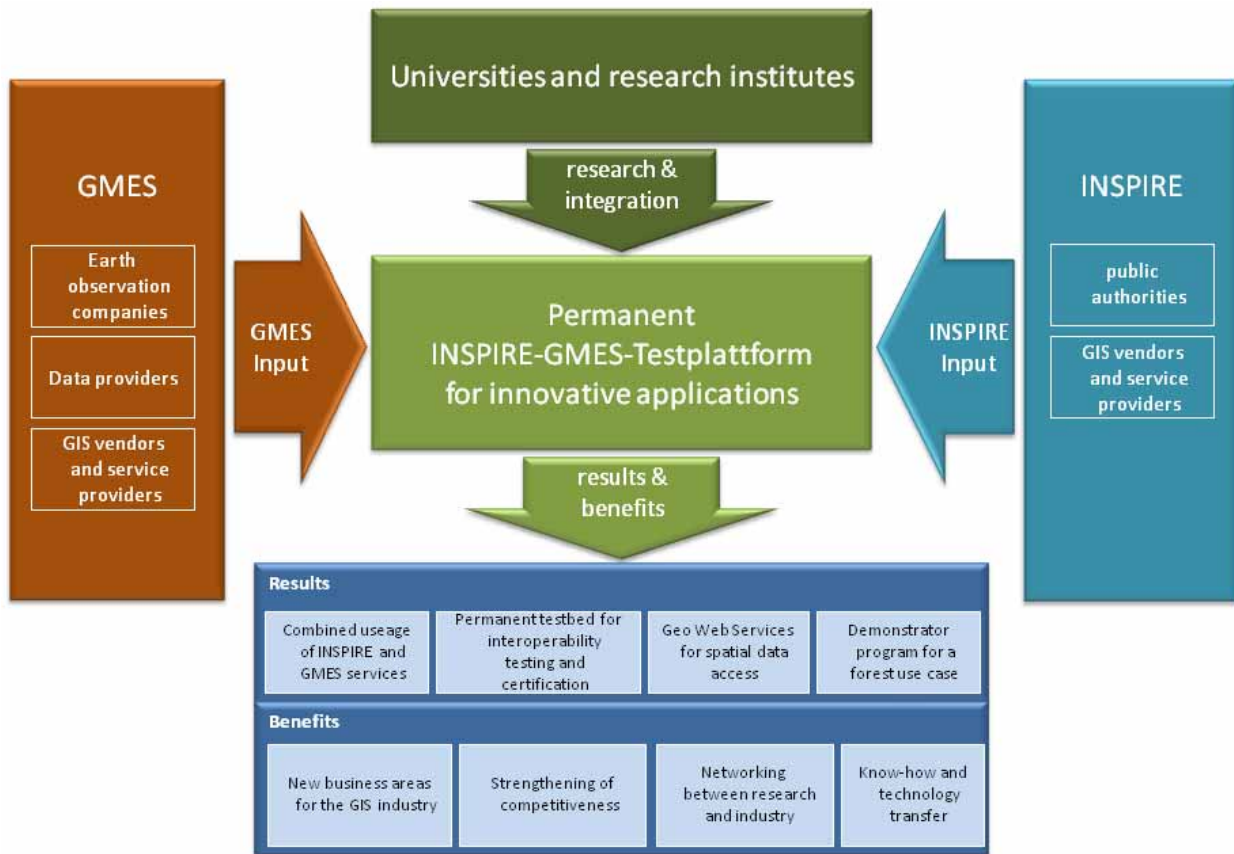


Figure 4: Overview of the INSPIRE-GMES-Testplattform concept

### Metadata on the INSPIRE-GMES-Testplattform

In accordance with the INSPIRE road map, the project's first phase dealt with the topic of metadata. The Lake Constance region was chosen as cross-border test area (see figure 5) including a multitude of different GIS, datasets, data models and data transfer formats.

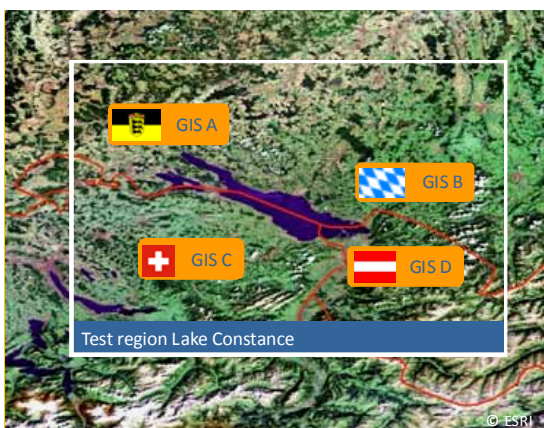


Figure 5: Initial conditions in the Lake Constance test area

During this phase of the project, seven project partners provided metadata catalogues with a Catalogue Service Web (CSW) interface, which contained metadata from Germany, Austria and Switzerland. The CSW interface enables the interoperable use of metadata via web services. The catalogues' conformance to the CSW 2.0.2 AP ISO 1.0 profile was tested using the TEAM

Engine of GDI-DE. In addition to that, metadata elements in selected metadata sets were analyzed with regard to the requirements of the INSPIRE regulation on metadata<sup>34</sup> as well as the accompanying technical guidelines<sup>35</sup>. A prototype which can be used for thematic and spatial search of data sets across all catalogues as well as visualisation of the results in earth viewers was developed at Technische Universität München.

### Results concerning metadata

The combined usage of metadata was feasible, albeit with certain limitations. While the CSW standard enables syntactical interoperability (uniform access), the metadata sets still differed considerably in their content. Thus they didn't allow yet for full semantic interoperability (comparability of contents) and combined usage. Semantic interoperability to be achieved by INSPIRE will improve the metadata's usability considerably.

Concerning the metadata catalogues, great progress has been made in implementing the OGC CSW interface since CSW version 2.0.1. Main challenges with regard to INSPIRE include the CSW operations harvest and transaction (which are mandatory in INSPIRE as opposed to the OGC specification), the usage of SOAP

<sup>34</sup> European Commission 2008b

<sup>35</sup> European Commission Joint Research Centre 2009

envelopes for message transport as well as the implementation of the INSPIRE metadata profile.

Tests showed that recent catalogue systems implement the CSW 2.0.2 ISO AP 1.0 in a largely compliant way and in part already offer INSPIRE compliance. Older implementations are sometimes slightly inaccurate. This includes differences in the usage of prefixes, the encoding of SOAP envelopes and the structure of the ISO 19139 XML documents generated.

**View Services**

In the ongoing second project phase, the link between metadata, spatial data sets and services was implemented for a test area in the German states Saxony and Thuringia. In doing so, the so-called publish find bind principle is applied (see figure 6).

Data sets are described by metadata and are published in a registry (e.g. the INSPIRE geoportal). They can then be discovered and accessed via web services (e.g. view service and download service)



In case of the INSPIRE-GMES-Testplattform this meant providing view services for spatial data in addition to metadata catalogues. For the time being, OGC Web Map Services (WMS) are used which are adapted to the INSPIRE view service requirements as far as possible. The services are operated by the project partners. Metadata is crucial to enable a coherent publish find bind process.

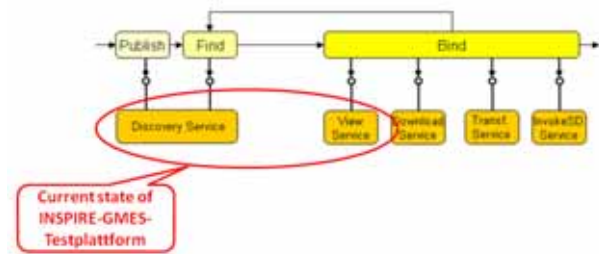


Figure 6: Linking INSPIRE network services (Network Services Drafting Team 2008)

**Innovative spatial applications combining INSPIRE and GMES**

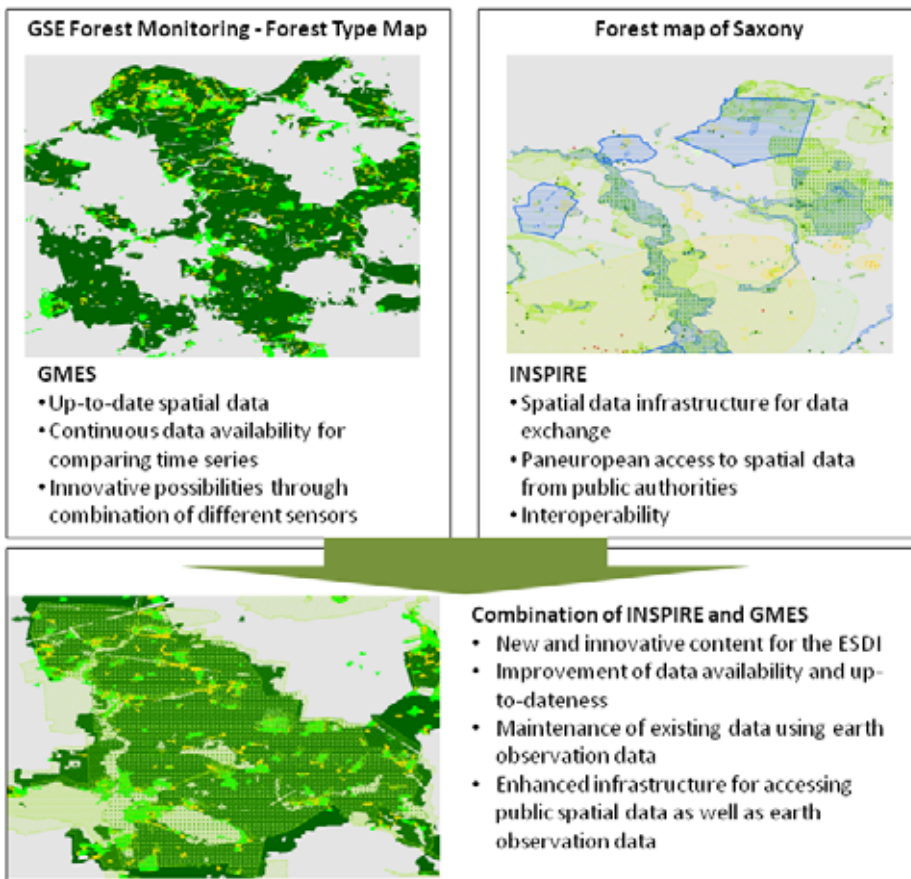


Figure 7: Benefits of combining INSPIRE and GMES

The project aims at bridging the gap between INSPIRE and GMES services. Current calls for GMES projects already incorporate INSPIRE requirements. In the current phase of the project the link will be achieved via INSPIRE services providing GMES data.

A potential use case in the environmental domain could be the modelling of critical loads. This refers to the determination of a maximum load of pollutants a natural landscape unit can degrade autonomously without being permanently damaged. In addition to information about pollution and climatic conditions, also spatial data describing the landscape unit serve as input parameters for the calculation. This includes e.g. soil types and vegetation.

Spatial data falling under the INSPIRE directive's annexes has to be provided by environmental agencies using web services. Public data on protected sites and forest types from the German states Saxony and Thuringia are used in the scenario.

GMES data from remote sensing satellites and sensor networks is very useful for assessing the current state of the environment. For determining the current forest cover – an important parameter for modelling critical loads – satellites with sensors for the infrared range are well suited. They can be used to produce up-to-date and accurate forest maps (c.f. the GMES-Projekt GSE Forest Monitoring)

INSPIRE and GMES are complementary. Combining data from these two European initiatives therefore enables more efficient provision of information on the state of the environment (see figure 7).

The combined usage of services is tested using a central aggregating service. This service allows for metadata search and subsequent visualisation of the data discovered in web GIS clients.

The scenario starts with a search for data sets suitable for critical loads modelling based on metadata. After the discovery and evaluation of the data sets they are to be accessed jointly using web services. INSPIRE foresees view and download services for this purpose. Within the INSPIRE-GMES-Testplattform, the services are accessed from web GIS clients provided by different project partners. In principle, the services could also be used as input parameters for modelling critical loads.

Summing up, the workflow consists of the following steps (see figure 8):

1. A web form allows for thematic and spatial search of spatial data across distributed metadata catalogues. The search results are displayed in an Earth Viewer in order to allow for a more graphic search for data. The user interactively moves in an Earth Viewer and the footprints of the individual data sets within a region are visualised.
2. The metadata records can be accessed via links. The XML document delivered by the metadata catalogues is processed and displayed as HTML page including the most important metadata elements and a thumbnail.
3. Finally – in case the data are available via a web service – they can be displayed in a browser or various web GIS clients.

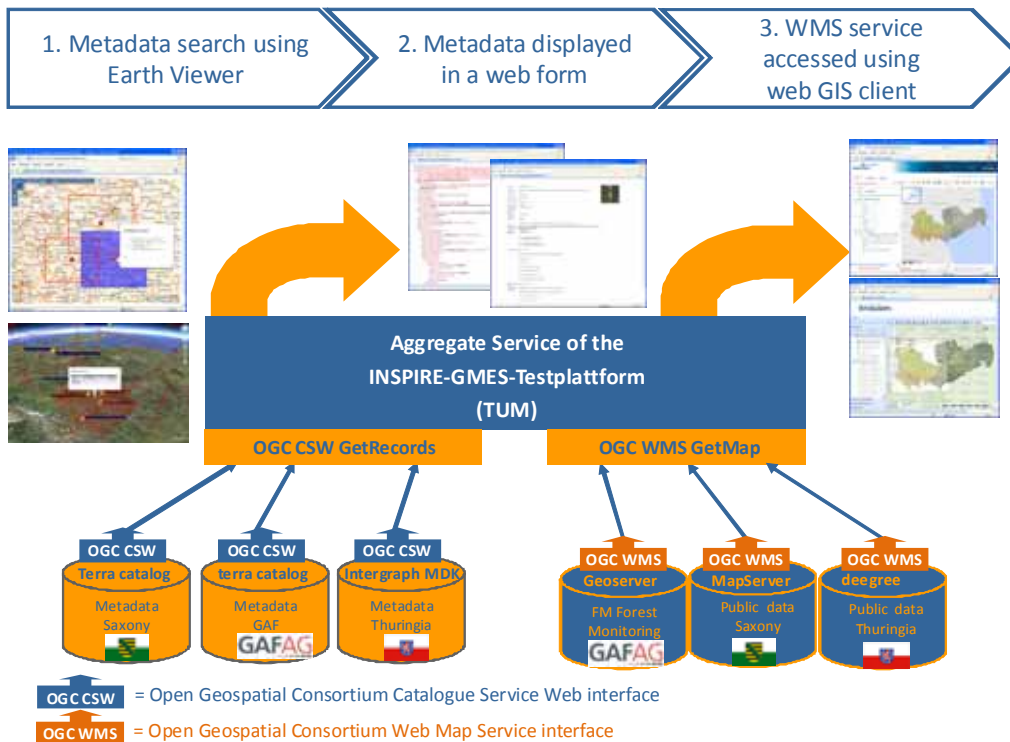


Figure 8: Use case application workflow

### Results from the INSPIRE-GMES-Testplattform

- First experiences regarding the INSPIRE implementation and exchange of know-how with other project partners
- Elaboration of the use cases „Metadata“ and „Critical Loads“
- Creation of a testing environment including spatial data sets and services from different European countries which can be used to implemented further use cases.
- Combined usage of services from different software systems in a workflow from metadata search to visualisation of the data sets in a Web GIS client
- Joint usage of INSPIRE and GMES data

### Benefits of the INSPIRE-GMES-Testplattform

The successful implementation of the European Spatial Data Infrastructure requires a central compliance testing facility, as offered by the coordination office GDI-DE, as well as a permanent testing environment, as provided by the INSPIRE-GMES-Testplattform. The latter offers the possibility to evaluate the interoperability of the heterogeneous components and demonstrate the benefit of the service oriented architecture approach by means of use cases. Active commitment of all stakeholders involved will remain crucial for the success.

Especially when it comes to the challenging parts of INSPIRE implementation – e.g. the download services, the prototypical tests will gain even more importance. The European Commissions' intent to offer GMES services in an INSPIRE compliant manner will result in additional challenges and will presumably enhance the importance of Web Coverage Service (WCS). While the GIGAS action in support of the Seventh European Framework Programme aims at the harmonisation of OGC, INSPIRE, GMES and GEOSS standards from a conceptual point of view, currently no interoperability tests are conducted in practice. While the European Space Agency (ESA) offers the HMA-T and the Service Support Environment (SSE) for testing services, the INSPIRE budget leaves no room for the operation of a permanent testing environment. Accordingly, the stakeholders which are affected by INSPIRE have to be proactive and willing to cooperate for a successful implementation of the directive. The Runder Tisch GIS e.V. wants to support its members in facing this challenge.

*"The INSPIRE-GMES-Testplattform is unique in Germany concerning its development and application stage. With this project, the Runder Tisch GIS association has set a signal to start the INSPIRE implementation, enabling users to test their data in a simple way."*

Udo Stichling, Deutscher Dachverband für Geoinformation e.V.



## 6. Conclusions and Outlook

The INSPIRE directive establishes the basis for a spatial data infrastructure at the EU level, enabling Europe-wide, cross-institutional, cross-border, interoperable access to and usage of spatial data and spatial data services. This provides great opportunities for all stakeholders in the SDI field as well as for the general public. The directive will open up new markets especially for companies in the spatial information industry, for example by offering tools for the interoperability required by INSPIRE.

However, implementing the INSPIRE directive also poses great challenges to all stakeholders. Well over two years after being published, it is no longer a topic of the future but of today<sup>36</sup>. Already today it is recommended to take the emerging requirements of the INSPIRE directive as well as the implementing rules and technical guidelines into account when taking IT decisions. In order to fulfil the directive, technical and organisational measures have to be taken by the public authorities concerned. Different approaches and different implementation stages can be observed in the various German states. But it definitely looks like the INSPIRE process has given a fresh impetus to the establishment of spatial data infrastructures on all levels of public administration and initiated new collaborations between public administration, industry and science.

Information and communication remain key factors for the acceptance and success of the INSPIRE implementation. It is important to clarify the question which authorities on all levels of government are actually concerned and to illustrate the benefits and opportunities of INSPIRE. All stakeholders have to be involved to avoid possible uncertainties. At the lower levels of public administration, e.g. in smaller municipalities and rural districts, the lack of resources for the partially complex implementation is still a big issue.

Runder Tisch GIS e.V. supports the implementation of the INSPIRE directive by providing information and consulting as well as funding for research. The INSPIRE brochure will continue to be periodically updated, taking into consideration current developments e.g. in the INSPIRE implementing rules. The next version will be released during the "15. Münchner Fortbildungsseminar Geoinformationssysteme" conference event held in March 2010. The Runder Tisch GIS e.V. will also offer training courses on INSPIRE fundamentals, services and data harmonisation in conjunction with this event. Runder Tisch GIS e.V. takes a big step towards the implementation of the directive by establishing the INSPIRE-GMES-Testplattform.

This project provides Runder Tisch GIS e.V. members with a testing environment, in which they can try out INSPIRE relevant processes and products and get prepared for the challenges arising from the directive.

*"Administration and industry face the challenge of creating an operational SDI, which convinces its users in their day-to-day business." (transl.)*

Prof. Lars Bernard,  
Technische Universität Dresden



## 7. Acknowledgements

On behalf of Runder Tisch GIS e.V., the authors would like to thank all persons who contributed to this brochure. Special thanks go to Prof. Norbert Bartelme of TU Graz, Lucia Erdt of Regionalverband Donau-Iller, Jens Hartmann of Intergraph SG&I Deutschland GmbH, Martin Lenk and Andreas von Dömming of Koordinierungsstelle GDI-DE, Markus Seifert of Geschäftsstelle Geodateninfrastruktur Bayern, Dr. Peter Staub of swisstopo, Dr. Wolfgang Steinborn of DRL, Christoph Uhlenkücken of con terra GmbH and Thomas Witke of GDI-Kompetenzzentrum Baden-Württemberg. In addition, Runder Tisch GIS e.V. would like to thank all partners of the INSPIRE-GMES-Testplattform as well as Volker Kraut, Florian Straub and all other employees of Technische Universität München involved in this project.

<sup>36</sup> Business Geomatics Fokus 1/2008

## List of Abbreviations

<b>AAA</b>	AFIS-ALKIS-ATKIS
<b>AP</b>	Application Profile
<b>BMU</b>	Bundesministerium für Umwelt
<b>CSW</b>	Catalogue Service Web
<b>INSPIRE</b>	Infrastructure for Spatial Information in the European Community
<b>ISO</b>	International Organization for Standardization
<b>IT</b>	Information Technology
<b>EO</b>	Earth Observation
<b>ESA</b>	European Space Agency
<b>ESDI</b>	European Spatial Data Infrastructure
<b>EU</b>	European Union
<b>GDI</b>	Geodateninfrastruktur
<b>GeoIG</b>	Geoinformationsgesetz (Switzerland)
<b>GEOSS</b>	Global Earth Observing System of Systems
<b>GeoZG</b>	Geodatenzugangsgesetz
<b>GIGAS</b>	GEOSS, INSPIRE and GMES an Action in Support
<b>GIS</b>	Geographic Information System
<b>GMES</b>	Global Monitoring for Environment and Security
<b>HMA</b>	Heterogeneous Missions Accessibility
<b>HMA-T</b>	HMA Testbed
<b>HTML</b>	Hyper Text Markup Language
<b>IGTP</b>	INSPIRE-GMES-Testplattform
<b>KML</b>	Keyhole Markup Language
<b>NGDI</b>	Nationale Geodaten-Infrastruktur (Switzerland)
<b>OGC</b>	Open Geospatial Consortium
<b>RTG</b>	Runder Tisch GIS e.V.
<b>SDI</b>	Spatial Data Infrastructure
<b>SEIS</b>	Shared Environmental Information System
<b>SISE</b>	Single Information Space in Europe for the Environment
<b>SOA</b>	Service Oriented Architecture
<b>SOAP</b>	Simple Object Access Protocol
<b>SSE</b>	Service Support Environment
<b>UML</b>	Unified Modelling Language
<b>WCS</b>	Web Coverage Service
<b>WFS</b>	Web Feature Service
<b>WMS</b>	Web Map Service
<b>WSDL</b>	Web Services Description Language
<b>XML</b>	Extensible Markup Language

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## Annex

### A. Spatial Data Themes Listed in the INSPIRE Directive's Annexes

<b>Annex I</b>	
<b>Spatial Data Theme</b>	<b>Definition</b>
Coordinate reference systems	Systems for uniquely referencing spatial information in space as a set of coordinates (x, y, z) and/or latitude and longitude and height, based on a geodetic horizontal and vertical datum
Geographical grid systems	Harmonised multi-resolution grid with a common point of origin and standardised location and size of grid cells
Geographical names	Names of areas, regions, localities, cities, suburbs, towns or settlements, or any geographical or topographical feature of public or historical interest
Administrative units	Units of administration, dividing areas where Member States have and/or exercise jurisdictional rights, for local, regional and national governance, separated by administrative boundaries
Addresses	Location of properties based on address identifiers, usually by road name, house number, postal code
Cadastral parcels	Areas defined by cadastral registers or equivalent
Transport networks	Road, rail, air and water transport networks and related infrastructure. Includes links between different networks
Hydrography	Hydrographic elements, including marine areas and all other water bodies and items related to them, including river basins and sub-basins. Where appropriate, according to the Water Framework Directive
Protected sites	Area designated or managed within a framework of international, Community and Member States' legislation to achieve specific conservation objective
<b>Annex II</b>	
<b>Spatial Data Themes</b>	<b>Definition</b>
Elevation	Digital elevation models for land, ice and ocean surface. Includes terrestrial elevation, bathymetry and shoreline
Land cover	Physical and biological cover of the earth's surface including artificial surfaces, agricultural areas, forests, (semi-)natural areas, wetlands, water bodies
Orthoimagery	Geo-referenced image data of the Earth's surface, from either satellite or airborne sensors
Geology	Geology characterised according to composition and structure. Includes bedrock, aquifers and geomorphology
<b>Annex III</b>	
<b>Spatial Data Themes</b>	<b>Definition</b>
Statistical units	Units for dissemination or use of statistical information
Buildings	Geographical location of buildings
Soil	Soils and subsoil characterised according to depth, texture, structure and content of particles and organic material, stoniness, erosion, where appropriate mean slope and anticipated water storage capacity
Land use	Territory characterised according to its current and future planned functional dimension or socio-economic purpose (e.g. residential, industrial, commercial, agricultural, forestry, recreational)
Human health and safety	Geographical distribution of dominance of pathologies (allergies, cancers, respiratory diseases, etc.), information indicating the effect on health (biomarkers, decline of fertility, epidemics) or well-being of humans (fatigue, stress, etc.) linked directly (air pollution, chemicals, depletion of the ozone layer, noise, etc.) or indirectly (food, genetically modified organisms, etc.) to the quality of the environment
Utility and governmental services	Includes utility facilities such as sewage, waste management, energy supply and water supply, administrative and social governmental services such as public administrations, civil protection sites, schools and hospitals
Environmental monitoring facilities	Location and operation of environmental monitoring facilities includes observation and measurement of emissions, of the state of environmental media and of other ecosystem parameters (biodiversity, ecological conditions of vegetation, etc.) by or on behalf of public authorities
Production and industrial facilities	Industrial production sites, including installations covered by Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control and water abstraction facilities, mining, storage sites
Agricultural and aquaculture facilities	Farming equipment and production facilities (including irrigation systems, greenhouses and stables)
Population distribution — demography	Geographical distribution of people, including population characteristics and activity levels, aggregated by grid, region, administrative unit or other analytical unit
Area management/restriction/regulation zones and reporting units	Areas managed, regulated or used for reporting at international, European, national, regional and local levels. Includes dumping sites, restricted areas around drinking water sources, nitrate-vulnerable zones, regulated fairways at sea or large inland waters, areas for the dumping of waste, noise restriction zones, prospecting and mining permit areas, river basin districts, relevant reporting units and coastal zone management areas

Natural risk zones	Vulnerable areas characterised according to natural hazards (all atmospheric, hydrologic, seismic, volcanic and wildfire phenomena that, because of their location, severity, and frequency, have the potential to seriously affect society), e.g. floods, landslides and subsidence, avalanches, forest fires, earthquakes, volcanic eruptions
Atmospheric conditions	Physical conditions in the atmosphere. Includes spatial data based on measurements, on models or on a combination thereof and includes measurement locations
Meteorological geographical features	Weather conditions and their measurements; precipitation, temperature, evapotranspiration, wind speed and direction
Oceanographic geographical features	Physical conditions of oceans (currents, salinity, wave heights, etc.).
Sea regions	Physical conditions of seas and saline water bodies divided into regions and sub-regions with common characteristics
Bio-geographical regions	Areas of relatively homogeneous ecological conditions with common characteristics
Habitats and biotopes	Geographical areas characterised by specific ecological conditions, processes, structure, and (life support) functions that physically support the organisms that live there. Includes terrestrial and aquatic areas distinguished by geographical, abiotic and biotic features, whether entirely natural or semi-natural
Species distribution	Geographical distribution of occurrence of animal and plant species aggregated by grid, region, administrative unit or other analytical unit
Energy resources	Energy resources including hydrocarbons, hydropower, bio-energy, solar, wind, etc., where relevant including depth/height information on the extent of the resource
Mineral resources	Mineral resources including metal ores, industrial minerals, etc., where relevant including depth/height information on the extent of the resource

## B. Contact Points for Information on the INSPIRE Directive (as of 07.09.09)

Institution / Level	Contact Person	E-mail
Runder Tisch GIS e.V.	Dr.-Ing. Gabriele Aumann	<a href="mailto:gabriele.aumann@bv.tum.de">gabriele.aumann@bv.tum.de</a>
Baden-Wuerttemberg	GDI-Kompetenzzentrum beim Landesamt für Geoinformation und Landentwicklung	<a href="http://www.geoportal-bw.de">http://www.geoportal-bw.de</a>
Bavaria	GDI-BY Geschäftsstelle	<a href="http://www.gdi.bayern.de">http://www.gdi.bayern.de</a>
German	Koordinierungsstelle GDI-DE, Dr. Martin Lenk	<a href="mailto:mail@gdi-de.org">mail@gdi-de.org</a>
Europäische Union	European Commission, represented by DG Environment and the Joint Research Center (JRC)	<a href="http://inspire.jrc.ec.europa.eu">http://inspire.jrc.ec.europa.eu</a>

## C. Representatives of German Organisations in INSPIRE Drafting Teams (as of 07.09.09)

Drafting Team	Representative
Metadata	Kristian Senkler (con terra GmbH) Thomas Vögele (Koordinierungsstelle PortalU im Niedersächsischen Ministerium für Umwelt und Klimaschutz)
Data and Service Sharing	Martin Lenk (Koordinierungsstelle GDI-DE)
Data Specifications	Clemens Portele, Leiter (interactive instruments GmbH) Andreas Illert (Bundesamt für Kartographie und Geodäsie) Heiz Habrich (Bundesamt für Kartographie und Geodäsie) Markus Seifert (Landesamt für Vermessung und Geoinformation)
Network Services	Lars Bernard (Technische Universität Dresden) Markus Müller (AED-SICAD AG) Roland M. Wagner (Universität Münster) Christian Elfers (con terra GmbH)
Monitoring and Reporting	Ute Dauert (Umweltbundesamt)

**D. INSPIRE Contact Persons of INSPIRE-GMES-Testplattform Project Partners (as of 07.09.09)**

<b>Company / Institutio</b>	<b>Contact Person</b>	<b>E-Mail</b>
AED-SICAD AG	Markus Müller	mueller@AED-sicad.de
Autodesk GmbH	Matthias Liechti	matthias.liechti@autodesk.com
Bayerisches Landesamt für Vermessung und Geoinformation	Markus Seifert	markus.seifert@lvg.bayern.com
Bentley Systems Germany GmbH	Daniel Holweg	daniel.holweg@bentley.com
Bundesamt für Kartographie und Geodäsie	Dr. Manfred Endrullis	manfred.endrullis@bkg.bund.de
con terra GmbH	Christoph Uhlenkücken	conterra@conterra.de
ESG – Elektroniksystem- und Logistik-GmbH	Dr. Karin Hosse	karin.hosse@esg.de
ESRI Deutschland GmbH	Dr. Gerd Buziek	info@ESRI-Germany.de
Fachhochschule Vorarlberg	Bernd Wenzel	bernd.wenzel@fhv.at
Freiberuflicher Software Entwickler	Thorsten Kunkel	tk@thorsten-kunkel.de
GAF AG	Matthias Schulz	matthias.schulz@gaf.de
GEOSYSTEMS GmbH	Dr. Ursula Benz	U.Benz@geosystems.de
GeoTask AG	Niklas Panzer	npanzer@geotask.ch
HHK Datentechnik GmbH	Lutz Ludwig	rundertisch@hkk.de
hubermedia GmbH	Stefan Huber	stefan.huber@hubermedia.de
IAC mbH Leipzig	Rolf Lüdicke	rolf.luedicke@iac-leipzig.de
Intergraph SG&I Deutschland GmbH	Dr. Jens Hartmann	jens.hartmann@intergraph.com
IP Syscon GmbH	Dr. Roman Radberger	radberger@ipsyscon.de
Landesamt für Geoinformation und Landentwicklung	Dieter Hess	dieter.hess@vermbw.bwl.de
Landesvermessungsamt Vorarlberg	Martin Seebacher	landesvermessungsamt@vorarlberg.at
Landratsamt Cham	Dr. Ulrich Huber	ulrich.huber@lra.landkreis-cham.de
M.O.S.S. Computer Grafik Systeme GmbH	Philipp Willkomm	pwillkomm@moss.de
Microsoft Deutschland GmbH	Jana Davis	jadavis@microsoft.com
Runder Tisch GIS e.V.	Dr. Gabriele Aumann	gabriele.aumann@bv.tum.de
Technische Universität München	Astrid Fichtinger	astrid.fichtinger@bv.tum.de

E. INSPIRE Architecture Overview (Bernard 2008)

