Discover INSPIRE compliant harmonised soil data and services

www.gssoil-portal.eu

Assessment and strategic development of INSPIRE compliant Geodata-Services for European Soil Data

GS Soil 06/2009 – 05/2012
CONTRIBUTING AUTHORS

PARTNER INSTITUTIONS
1. Coordination Center Portal U at the Lower Saxon Ministry of Environment, Energy and Climate Protection, GERMANY
2. Federal Research and Training Center for Forest, Natural Hazards and Landscape, AUSTRIA
3. Environment Agency Austria, AUSTRIA
4. Austrian Agency for Health and Food Safety, AUSTRIA
5. Paris Lodron University of Salzburg, Centre for Geoinformatics, AUSTRIA
6. Vlaamse Overheid – Departement Leefmilieu, Natuur en Energie, BELGIUM
7. Infologica Ltd., BULGARIA
8. Institute of Soil Science Nikola Poushkarov, BULGARIA
9. Czech Environmental Information Agency, CZECH REPUBLIC
10. Masaryk University, CZECH REPUBLIC
11. Federal Institute for Geosciences and Natural Resources, GERMANY
12. con terra GmbH, GERMANY
13. Fraunhofer Institute for Computer Graphics Research, GERMANY
14. wemove digital solutions GmbH, GERMANY
15. University of Aarhus, DENMARK
16. Spanish National Research Council, SPAIN
17. MTT Agrifood Research Finland, FINLAND
18. Alsace Region, FRANCE
19. Aristotle University of Thessaloniki, GREECE
20. Institute of Geology and Mineral Exploration, GREECE
22. National Food Chain Safety Office, HUNGARY
23. Center for Agricultural Research, Hungarian Academy of Sciences, HUNGARY
24. Szent István University, HUNGARY
25. University of Miskolc, Dept. of Physical Geography and Environmental Sciences, HUNGARY
26. Irish Agriculture and Food Development Authority, IRELAND
27. Warsaw University of Technology, POLAND
28. EDISOFT s. a., PORTUGAL
29. National Institute for Biological Recourses, PORTUGAL
30. National Research and Development Institute for Soil Science Agricultural Chemistry and Environment, ROMANIA
31. Soil Science and Conservation Research Institute, SLOVAKIA
32. Agri-Food & Biosciences Institute, UNITED KINGDOM
33. Agricultural Institute of Slovenia, SLOVENIA
34. The James Hutton Institute, UNITED KINGDOM
Population growth and increasing land use intensity lead to growing demands and exploitation of natural resources. Soils are among the most important and most endangered natural resource entities. In order to plan and implement sustainable soil management practices and to facilitate the rational exploitation of the resource, more detailed information on the occurrence of soils, its particular characteristics, potential risks, and hazards is needed. Soil conservation and its sustainable use are implemented through political initiatives such as the Common Agricultural Policy, Nitrate Directive, Soil Thematic Strategy, and other programmes. The draft Soil Directive for instance also addresses consistent soil information at a target scale of 1:250 000 for reporting requirements across Europe.

Within the INSPIRE directive (INfrastructure for SPatial InfoRmation in Europe), soils are explicitly addressed as an individual theme and besides that, soil-related environmental, agricultural and forestry aspects are also denoted. Activities taking place in INSPIRE are very often accompanied by research and development. In the case of INSPIRE and soil, the GS Soil project has been implemented under the DG Information Society & Media eContentplus programme. It aims at establishing a European network to improve the access to spatial soil data using principles, standards and definitions not having been developed at the starting point of GS Soil. The project considers aspects of data organisation, data harmonisation as well as semantic and technical interoperability in order to produce seamless geospatial information on soil based on a Spatial Data Infrastructure (SDI).

In order to cope with these needs for soil information, an increasing amount of data about soils must be made accessible and shared across disciplines, such as climate, land use and environmental observation. The exchanged data must be interoperable so that data users can process and combine soil information with digital information from neighbouring disciplines. Guidance on harmonisation is needed so that information from different sources can be understood, compared and interpreted across administrative borders.
It has been recognised that an easy cross-border access to data is the key to design successful politics, especially environmental policies and activities. Today electronic maps are a basic concept for planning and decision making in all areas of environmental politics. The availability and accessibility of environmental information held by or held for public authorities and business are getting more and more important. On the one hand, an increased access and visual representation of environmental information for the public is essential for attracting greater awareness of environmental matters. A free exchange of views and more effective participation by the public in environmental decision-making is taking place. On the other hand, detailed knowledge and information about the environment are required to ensure that the environmental policy-making of the European community considers regional and local differences while discovering the European picture.

The GS Soil project can be seen as best practice example providing an overview of the GS Soil activities and results for the practical implementation of a European Spatial Data Infrastructure for soil information. Thus, designed for the users, “soil” arrived in the INSPIRE reality! The results of the GS Soil network can be regarded as a significant step forward in increasing the accessibility of soil relevant information and enabling government taking decisions.
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1. Main objectives and results

The project GS Soil aimed at establishing a European network to improve the access to spatial soil data for public sector bodies, private companies and citizens. The project considered aspects of data organisation, data harmonisation as well as semantic and technical interoperability in order to produce seamless geospatial soil information and to improve the data access for a wider community of different user groups. The structural specification for the description and harmonisation of spatial soil data within Europe as well as the operation of a corresponding Spatial Data Infrastructure (SDI) were main objectives of the GS Soil consortium. Technical and syntactic interoperability have been ensured by the use of open standards such as published by the Open Geospatial Consortium (OGC) and the INSPIRE Specifications on Network Services. As a result, soil data providers offer their data via OGC compliant Web Feature Services (WFS) or Web Map Services (WMS), ensuring that the GS portal and other client systems are capable of accessing and displaying the distributed data.

A generic application schema for soil data serves as a backbone for data interoperability. Using a number of international OGC and other standards the partners established and operated a network of services for spatial datasets and metadata. This network includes distributed services for data transformation, discovery, view and best practice for download, and Intellectual Property Rights (IPR).

The central result of the project is the GS Soil portal. European soil data from heterogeneous sources are bundled here and best practice expertise is exposed. In order to ensure transnational usability of the portal and related services, aspects of multilingualism and data interpretation were considered thoroughly. In this respect, the harmonisation of metadata and the definition of terms and conditions have been addressed with supporting tools and explanatory documents.

During the lifetime of the project, partners extensively supported the implementation of the INSPIRE requirements on basis of available experience in selected European countries and regions on different organisational levels. This ensures that users are now able to discover, view and download soil data across Europe. Please feel free to have a look to our technical developments on > www.gssoil-portal.eu <.

We also invite you to have an in depth review on all the details of the brochure topics in the specific publicly available deliverables. These are indicated with this identifier > 🎨 < throughout the brochure and are available on the before mentioned website.
### Content Provision Framework

- Final consolidated soil related theme catalogue and inventory of soil resources providers (D2.3)
- Final Content Intellectual Property Rights assessment (D2.4)
- Best practice guidelines for developing a content framework for inter-operable soil data in Europe (D2.5)

### Data Management and Metadata

- Metadata profile for soil geographic datasets and dataset series (D3.1)
- Metadata profile for soil geographic data services (D3.2)
- Final best practice guidelines for creating and maintaining metadata for soil databases (D3.4)
- Establishment of a multilingual soil specific thesaurus – SoilThes (D3.5)

### Harmonisation and semantic Interoperability

- Theme specific test suite for developing data specifications (D4.1)
- Generic application schemes for soil information (D4.2)
- Data harmonisation best practice guidelines (D4.3) including test case reports on including nine test case reports

### GS Soil Portal and its integrated network

- Design specifications of GS Soil portal and network (D5.1)
- GS Soil portal prototype (D5.2)
- GS Soil portal and open tools and services (D5.3)
- Implementation and Integration Report (D5.5)
- (GEO)FOSS installation and use guidelines (D5.6)

### Evaluation and Sustainability

- Final long-term operation plan for the soil portal (D6.1)
- Reports on evaluation results of user testing (D6.2)

### Dissemination and Awareness

- Dissemination and awareness plan (D7.2)
- Networking and clustering activities (D7.4)
- Conference publications (D7.5)
- Annual reports, final project report

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**Figure 1:** Main objectives and results
2. Best practice network GS SOIL

2.1 GS Soil project facts

The project was co-funded by the European Community programme eContentplus with 4.1 M € (total project volume 5.1 M €). It is a programme from the European Commission DG Information Society and Media with the objective to make digital content in Europe more accessible, usable and exploitable. GS Soil is thereby allocated to the area of geographic information. It focuses on the aggregation of existing national datasets into seamless cross-border datasets, which will serve for new information services and products, in particular with a view to reducing barriers related to one or more of the specific themes mentioned in annexes I-III of the INSPIRE Directive. The focus of GS Soil is thereby set on soil and soil related data. In the eContentplus programme, GS Soil is defined as a Best Practice Network (BPN) for geographic information.

<table>
<thead>
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<th>GS Soil</th>
<th>Title</th>
<th>Assessment and strategic development of INSPIRE compliant Geodata-Services for European Soil Data</th>
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<tr>
<td>Duration</td>
<td>June 2009 – May 2012 (36 month)</td>
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<tr>
<td>Funding</td>
<td>The project has received financial resources from the European eContentplus Programme, EC DG Information Society and Media</td>
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<td>Budget</td>
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<td>Countries in the network</td>
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<td>IT Partners</td>
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<tr>
<td>Soil Partners (data providers)</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Involved persons</td>
<td>&gt; 120</td>
<td></td>
</tr>
</tbody>
</table>
| **Thematic working groups (WG)** | **WG 2** “Content provision framework”  
| | **WG 3** “Data management and metadata”  
| | **WG 4** “Harmonisation and semantic interoperability”  
| | **WG 5** “GS Soil portal and integrated network”  
| | **WG 6** “Evaluation and sustainability”  
| | **Coordination**  
| | **Dissemination**  
| **Working group meetings** | 26  
| **Conferences and interim meetings** | 4  
| **Operational Management group and project review meetings** | 9  
| **Involvement of target users via feedback mechanisms** | 373  
| **Number of INSPIRE compatible metadata for soil datasets** | 1060  
| **Number of accessible services in the GS Soil portal (WMS, WFS)** | 44  
| **Number of accessible other soil related information (websites, pdf, jpg, etc.) in the GS Soil portal** | 5600  
| **Publications and contribution to EU events** | 27  
| **GS Soil link to other EU projects and initiatives** | 30  

2. Best practice network GS SOIL

2.2 The GS Soil network

The project consortium comprises more than 120 people coming from 18 EU member states. Project coordinator was the Coordination Center Portal at the Lower Saxony Ministry of Environment, Energy and Climate Protection (Germany).

Among the 34 partner institutions 24 partners out of the consortium have been soil data providers and made the data available for the network. They are representing a significant proportion of national soil data centres within the European Soil Bureau Network (ESBN) and related institutions. Hence, a complex and high quality data basis in a European context was assured.

Figure 3: The project consortium at the Kick-Off-meeting (04.06.2009)
The focus was on data provided by national and regional institutions. Beyond that, European institutions were also involved via the advisory board, as the European Environment Agency (EEA) and the Joint Research Centre (JRC) of the European Commission.

Figure 4: The project consortium at the Final Conference (02.05.2012)
2. Best practice network GS SOIL

2.3 The GS Soil partners

The following list comprises the project partners and their role in the project as either data provider and/or IT-expert. Several partners bring in expertise in both fields.

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Role</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Coordination Center PortalU at the Lower Saxony Ministry of Environment, Energy and Climate Protection (Lead-Partner)</td>
<td>IT</td>
</tr>
<tr>
<td>2</td>
<td>Federal Research and Training Center for Forest, Natural Hazards and Landscape</td>
<td>Data</td>
</tr>
<tr>
<td>3</td>
<td>Environment Agency Austria</td>
<td>Data &amp; IT</td>
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<td>4</td>
<td>Austrian Agency for Health and Food Safety</td>
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<td>6</td>
<td>Vlaamse Overheid – Departement Leefmilieu, Natuur en Energie</td>
<td>Data</td>
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<tr>
<td>7</td>
<td>Infologica Ltd.</td>
<td>IT</td>
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<tr>
<td>8</td>
<td>Institute of Soil Science Nikola Poushkarov</td>
<td>Data</td>
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<td>9</td>
<td>Czech Environmental Information Agency</td>
<td>Data &amp; IT</td>
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<td>10</td>
<td>Masaryk University</td>
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<td>11</td>
<td>Federal Institute for Geosciences and Natural Resources</td>
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<td>12</td>
<td>con terra GmbH</td>
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<td>Fraunhofer Institute for Computer Graphics Research</td>
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<td>wemove digital solutions GmbH</td>
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<td>20</td>
<td>Institute of Geology and Mineral Exploration</td>
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<td>Hellenic Agricultural Organisation – Demeter</td>
<td>Greece</td>
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<td>22</td>
<td>National Food Chain Safety Office</td>
<td>Greece</td>
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<td>23</td>
<td>Center for Agricultural Research, Hungarian Academy of Sciences</td>
<td>Hungary</td>
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<td>24</td>
<td>Szent Istvan University</td>
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<td>25</td>
<td>University of Miskolc, Dept. of Physical Geography and Environmental Sciences</td>
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<td>26</td>
<td>Irish Agriculture and Food Development Authority</td>
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<td>34</td>
<td>The James Hutton Institute</td>
<td>United Kingdom</td>
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2. Best practice network GS SOIL

2.4 Target user group

In the European member states and across Europe different kinds of users require consistent soil information, which are quality assured and understandable. The figure gives an overview of the different target user groups for soil information and their needs. Altogether, the retrieval, exchange and assessment of soil information was identified as most important aspects.

<table>
<thead>
<tr>
<th>Target user description</th>
<th>Needs</th>
<th>Involvement &amp; Role</th>
<th>Country coverage</th>
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| The public, especially citizens, students, interest groups | • Information access for process participation and awareness-building  
• Multilingual information access to facilitate cross-border interpretation  
• Access to cross-border information to assess European developments  
• Protection of soil and the natural heritage | Participation via feedback mechanisms regarding the assessment of usability and quality of the GS Soil portal. | All countries involved in data provision through the GS Soil portal. Planned: EU27 and accession countries. |
| Environmental administration, especially on national and regional level | • Easy access of reliable, standardised data  
• Comparison and benchmarking  
• Cost reduction  
• Service for the public  
• G2G, G2B services  
• Data access for higher-ranking administration  
• Protection of soil and natural heritage | Direct involvement:  
Partly partners of the consortium; driving force for the portal development, active data user and data providers. | Most EU-countries, esp. GS Soil participating countries; planned 100% coverage of EU27, at least via best practice guideline dissemination; legislative pressure to succeed in the process (Soil directive, EEID, INSPIRE). |
| Policy stakeholders: NGOs, PPP, Parties | • Policy-making  
• Access and interpretation of reliable datasets | Advisory Board members, involvement via feedback mechanisms | Selected country coverage |
<table>
<thead>
<tr>
<th>Target user description</th>
<th>Needs</th>
<th>Involvement &amp; Role</th>
<th>Country coverage</th>
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| Environmental/ scientific institutes, universities, private and public agencies on national and regional level | • Collection of harmonised national and cross-border datasets  
• Access of reliable, standardised data  
• Scientific interpretation and data analysis | Direct involvement: Partners of the GS Soil consortium; driving force for the portal development, active data user and provider | EU27 partly covered; more involvement planned via the dissemination measures and Advisory Board activities |
| EU Commission, EU Parliament, EU Institutions | • European wide access to geospatial data to support community policies  
• Improvement of environmental monitoring within the EU  
• Access to standardised data for structured impact assessments  
• Broad involvement of stakeholders  
• Environmental policy and legislation decision making | Continuous feedback by means of deliverables and feedback via the project process, direct involvement of the corresponding INSPIRE drafting teams and the JRC (European Soil Data Centre); Indirect involvement of the EEA | All EU Member states |
| Private Sector (services / industry), e.g.  
• GI-Industry  
• Construction industry  
• Planning companies  
• Soil related assessment companies | • Real estate evaluation  
• Environmental impact assessment  
• Improved services and applications related to spatial datasets  
• More demand oriented supply of the data from public authorities  
• Improvement of impact assessment by professional data provision | Direct involvement of GI-Industry in the consortium (partner) and key player; feedback mechanisms concerning service-industry using geospatial data | Selected country coverage; Involvement of selected industries in EU27 via usability and quality checks; Increase involvement through dissemination measures |
3. Soil data in Europe

3.1 Needs for soil data

Having identified the main target users, we identified the demanding needs and analysed that soil and soil related data contain important information about the spatial distribution of country’s soil types and other soil properties such as horizon depth, pH value, soil texture, organic matter content etc. Thus, physical, chemical and biological soil properties provide information on soil fertility for agricultural production, for determination of taxes for landowners or for environmental studies. The latter are more and more demanded in a world where overexploitation of resources is a big issue. Soil maps are for instance used for decision-making processes such as the evaluation of priority areas for agricultural production or spatial planning. These applications have increased the demand of soil data tremendously in the past decades. As a consequence, the web access of soil information became important due to the increasing intensity of international data exchange and transnational data exploitation at European level requiring the assessment, interpretation and harmonisation of national data sets following the INSPIRE principles.

The availability of soil information across Europe and soil data requirements from users have been investigated using questionnaires. The results were used to develop a comprehensive catalogue on soil data providers and on recently available soil data sets. The catalogue covers 335 soil information datasets such as general soil maps, sets of point data on basic soil parameters, soil thematic maps, information on soil status dynamics (soil monitoring data sets), etc. This soil related theme catalogue elaborated in deliverable D2.3 serves as a basis for further exploitation of data analysis, data harmonisation, and finally for the creation of a GS Soil portal.

Soil information users come from very different parts of the society and disciplines. Apart from traditional customers such as farmers, foresters and governmental authorities responsible for the management of agriculture and other land exploiting sectors, many new professional groups emerged. For example scientific and education institutions, environmental organisations (both governmental and non-governmental), municipal authorities and many others are nowadays in need of spatial soil thematic information.
3.2 Preparing soil data for INSPIRE

Having identified the cross-national need for soil data and having done an inventory of existing datasets across Europe (D2.5) it turned out that exchanging soil data is a very big challenge. Soil is a spatially continuous phenomenon. Its description, classification, and visualisation can take place in many different ways and has developed quite differently in the European countries during the last century. The same applies to all those procedures with which soil materials, their composition and physical properties are analysed in the laboratory. For some properties, several closely related parameters exist that nonetheless differ in their values and their meaning. Many quantitative values are given in classes instead of single values, considering their high spatial or temporal variability. Class definitions are often diverse between countries and adapted to the entire value range found within their boundaries, or to the aims of the individual soil investigation.

The identification of a common core structure of soil data seemed to be a reasonable approach to achieve technical interoperability between such diverse data. This essentially means finding those objects, which are described to characterise soil in the different systems. For the parameters, the need for object (or parameter-related) metadata is obvious, and a way to handle semi-quantitative values.

The already on-going effort of an ISO working group of the ISO Technical Committee 190 Soil Quality to produce a general approach for the digital exchange of soil-related data was taken up by the project. GS Soil contributed to the further development to the present committee draft of ISO 25258 delivered in January 2011 (D4.2). In principle, it is based on a non-extensible catalogue of objects and rules of how to define attribute parameters for these objects. Parameter definitions according to these rules include, for instance, code lists with relevant explanations for each code and class definitions of classified numerical values. With it, data users get all necessary information for the sound interpretation and use of the pedological data.

The application schema for soil data, definitions, and the work on soil theme-specific metadata were provided to the INSPIRE Thematic Working Group Soil, which took up several concepts and ideas. The GS Soil elaborations on metadata directly fed in the INSPIRE data specifications soil. In addition, GS Soil tested the INSPIRE data specifications soil version 2.0 as a “spatial data interest community” with data from several partners and commented on the data model and the accompanying text.
3. Soil data in Europe

3.3 Intellectual property rights

The term “intellectual property” refers broadly to the creations of the human mind. Intellectual Property Rights (IPRs) allow creators, or owners of patents, trademarks or copyrighted works, to benefit from their work or investment. Thus, the provision of soil information must accommodate access rights, permitted usages, charging rates (where applicable) as well as the rights and obligations of the defined parties. Experiences have shown that IPR aspects are considered as one of the most challenging endeavours in the data providing and data exchange process. This is especially true when data is not published under the open data initiative. This is a consequence of historical developments resulting from different political settings inferring different data holder responsibilities across Europe. The biggest challenge seems to be the dissimilar licence agreements across the data providers.

The work in GS Soil’s data harmonisation processes, the case study area implementations and the metadata and data model developments made it necessary to distinguish between different IPRs. These are mainly the data and/or services, which are run by partner institutions and provided via Web Feature Service (WFS), and/or Web Map Service (WMS) for further provision on the GS Soil portal as well as for new data and/or maps created and inserted to the GS Soil portal by different project partners.
Data access rights and IPR have been evaluated at European and national level, where project partners provided insight into the very different legal constraints and demands (D2.4). On metadata level, the IPR and terms of use are available for all datasets shown on the GS Soil portal. This is the underlying national legal basis, since the portal connects individual services distributed across the European member states.

However, not only system internally the copyrights need to be transparent. For the users it must be apparent how to deal with copyrights and data sources (e.g. click licences) without risking legal constraints or being charged for things not wanted. To ensure data application is restricted and the users are notified when copyrights or charges apply the GS Soil consortium clarified IPR issues of all datasets stored in the GS Soil portal in advance and now provides a transparent and practicable workaround for data users and data providers.

Figure 9: Intellectual Property Rights
4. Data harmonisation and exchange

4.1 Metadata for datasets & services

Metadata is the data or information on the data itself and thus refers to structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use or manage datasets, dataset series, and data services. It describes how to interpret the data values, for example what depth and date the soil property measurement comes from, where and when it has been obtained, how it was analysed, who the maintaining institution is and how to get the data.

The definition of a set of metadata elements is necessary in order to allow identification of the information resource for which the metadata is created. Its classification, as well as the identification of its geographic location and temporal reference, quality and validity, conformity with implementing rules on the interoperability of spatial data sets and services, constraints related to access and use, and the organisation responsible for the resource need to be captured. In addition, metadata elements related to the metadata record itself are necessary.

Most of the metadata necessary to describe a dataset or service are fixed in the regulation 1205/2008 which implements the INSPIRE directive with regard to metadata. In the framework of the GS Soil project specific metadata for the theme soil was determined for datasets and services (D3.1, D3.2). They are concerned with the description of different quality features of the data source but also other soil relevant aspects like information about the data sources from which the described dataset was created.
All defined metadata within the project was based on concepts of metadata in the EN ISO 19115 standard. Additional service-level metadata was defined in the EN ISO 19119 standard. From the implementation point of view the metadata for datasets and services were defined in both the EN ISO 19139 resulting in the XSD (eXtensible Stylesheet Definition) representation.

The GS Soil metadata profile was provided as reference material for the development of the data specification for the INSPIRE annex III theme soil. It is probable that the main part of the profile will be adopted to the metadata definitions in that data specification.

The metadata tools used in the project were adapted to the GS Soil setting. Thus, the project partners are now able to create GS Soil compatible metadata with the GeoNetwork opensource editor as well as with the InGrid-Editor. As a recommendation for the creation and maintenance of metadata for soil related databases, a Best Practice Guideline (BPG) was developed as one of the major deliverables of the GS Soil project (D3.4).
4. Data harmonisation and exchange

4.2 INSPIRE Interoperability criteria and data harmonisation

Harmonisation refers to the establishment of a pleasing consistent whole while creating common standards across the soil data providers and users in Europe. The harmonisation process integrates two basic types of soil information; polygons representing the defined Soil Mapping Units (SMU) and point datasets on the location of soil samples and observations entailing soil properties used for the representation of soil thematic maps. The harmonisation of attributes attached to the polygons and points requires cooperation between governments to make standards uniform and coherent. Moreover, harmonisation is required to ensure INSPIRE interoperability. INSPIRE should ensure the ability of two or more autonomous data sources or services to be combined and to foster the communication and cooperation among themselves in a meaningful and consistent way. This should take place despite differences in language, content or context. However, soil-mapping units such as basic graphic soil mapping elements are defined and mapped differently. This depends on the national classifications, mapping rules and surveyor’s interpretation. The methodologies used to elaborate soil maps are to a large extent country specific (D2.5). Due to the development of European countries since the beginning of the last century, soil data collection, mapping, and processing is in general based on national methods, procedures, experiences, and practices. Thus, data harmonisation requires technically interoperable soil data, clear definitions of the parameters, properties, types, and coding of the parameter values and possibly a minimum dataset that comprises any auxiliary information for meaningful or valid harmonisation procedures and soil quality information (D4.2). Here one needs to consider, that soil has both horizontal and vertical spatial variability and a very significant temporal variability of certain soil properties, like pH, soil moisture content, nutrient content. Thus, any interoperability attempt requires information on the horizontal and vertical sampling design, which has been elaborated in D3.4.

Based on the soil data and soil data types, data transfer structures have been developed which address technical interoperability by allowing the unambiguous exchange of soil data and their metadata. Technically interoperable data with clear definitions can subsequently be semantically harmonised using procedures that transform datasets into a common parameter and codification space at both the user and data provider level. This initial establishment of semantic interoperability produces seamless
geospatial information with improved data access for a wide community of different user groups. The established semantic web service aims to interchange of semantic data and to combine data from distributed sources and services without losing meaning. GS Soil could identify and laid down the harmonisation gaps and the content framework needed to develop a harmonised soil database in Europe. This supports the European Soil Bureau Network (ESBN) in attempting the provision of seamlessly available soil data across European member states.

Despite the underlying differences in database content and historical approaches to soil classification and mapping, a common approach with all GS Soil partners was to “translate” their local soil map legend. This has been done using common vocabulary for soil maps according to the World Reference Base (WRB) for soil resources. This translation step deals with the semantic interoperability required by the contextual and conceptual levels of the Enterprise Architecture approach (Figure D2.5, D4.3).

The application of WRB requires soil profile descriptions and soil analytical results according to common standards. In the case of soil profile description in Europe, this standard is increasingly viewed as the Food and Agriculture Organisation (FAO) guideline for soil profile description. Resulting from this work and the case study exercises following later, we could provide the following recommendations:

- Target a set of core attributes of key soil profile parameters for deriving knowledge from soil maps (pedotransfer functions; PTF) using the FAO guidelines.
- Harmonise the context and concepts of soil classifications into the WRB classification system.
- Develop adequate and transferable PTFs based on the FAO specifications using coded profile parameters.
- Support the development of digital soil mapping methods as only these enable derived and improved datasets.
- Decide on the specific spatial and temporal scale for the harmonised data.
- Capture definitions for the reference terminologies in the logical model used to describe the maps.
- Within the physical model, apply edge-match at country or regional boundaries.
- Establish a common approach to map unit generalisation within the physical model.
4. Data harmonisation and exchange

4.3 GS Soil test cases

The study of soils in their landscape context to develop an understanding of the geography of soil types and properties in Europe has a long history. Soil observation, classification and data collection methods have developed independently in each soil survey area. Concepts to describe soil profiles and their relation to the landscape were mainly developed prior to the onset of the digital era and are a conceptual data model formulation which is truly computing-platform-independent.

The harmonisation case studies in GS Soil (“test cases”) comprised the three broad types shown in Figure 13.

The test cases investigated three ‘pillars’ of harmonisation (Figure 14) which examine the following points:

- Matching local soil profile data to internationally accepted nomenclature (FAO Guidelines for Profile Description)
- Translation of local soil classification as represented by soil profile and map legends to the World Reference Base (WRB)
- Translation of actual soil profiles linked to map polygons
- Translation of derived profiles with summary properties
- Translation of map legends using expert knowledge
- Reference terminology for describing the content of soil maps
- Aggregation and disaggregation of map legend and content
There were some general harmonisation threads running through most test cases, in particular:

- Testing the compatibility of local soil profile observation methods with the FAO Guidelines for Profile Description.
- The translation of local soil profiles and/or local map legends to World Reference Base (WRB).
- In few countries, the comparisons of map complexity in similar geomorphic areas was conducted as a basis to compare the resolution of soil maps. This work was supplemented by calculating map indexes for two pilot projects of the European Soil Bureau Network (ESBN), the German-CZ Sheet Chemnitz, and the Polish-German-CZ Oder Basin map.

The results clearly demonstrate that data which are technically interoperable (as required under the INSPIRE Directive) are not comparable beyond country borders unless the information content is harmonised. The GS Soil test cases provide valuable insights into methods and work load to implement harmonisation.
4. Data harmonisation and exchange

4.4 Single country test cases

RESULTS

The major difficulty during harmonisation was due to the differences of both ambiguous soil classification systems, the Hungarian and the one from WRB. Hungarian soil types are mostly defined without strict definitions and numerical limits, while WRB has a strict diagnostic approach, based on measurements, to horizons and materials. In the Hungarian Soil Classification System the soil type level was used for correlation with WRB Reference Soil Group (RSG) as the detail is comparable. The translation provides a “best approximation” for correlation of Hungarian legacy soil data with WRB, and does not result in a “one-to-one” match. This is a finding with a more general application to soil datasets in Europe.
RESULTS

In the Slovenian soil classification, the higher-level soil types are very well defined, at lower levels in the classification, subtypes, varieties and forms are less accurately determined, so that there is room for subjectivity in the decision making process for WRB translation. These tighter and looser frameworks of reference terminology are common in the test cases. The test case includes in the district of Celje 1:25 000 / 1:10 000. 57 occurring Soil Typological Units (STU) (10 soil profiles) were translated into WRB. The translation was not straightforward: Lithological properties are not given as much emphasis in WRB compared to the Slovenian classification system.
RESULTS

There is a general limitation of a group of Belgian textural classes with no name. Part of the Belgian textural class heavy clay (class U) is qualified as “Siltic”.

Example maps 1:25 000 and 1:250 000 were produced applying WRB. The shown overlay of the Arenic, Siltic and Clayic qualifiers from WRB demonstrates a common difficulty with translating locally-measured texture classes into WRB qualifiers based on texture.
RESULTS

A simplified key for translating soil profiles to the WRB was developed in the Greece test case.

Forty soil profiles were selected and translated into WRB. The profiles are representative of the mapping units in a local area. Prefic and suffix qualifiers were identified as far as possible.
4. Data harmonisation and exchange

4.5 Border areas of two or more partners

Specific tests for border regions were the edge-matching of common soil units at the borders and the comparison of soil map geometry complexities in comparable landform regions.

Austria – Slovakia

RESULTS

The Austria-Slovakian test case concentrated on the harmonisation of soil data within a transnational test case area. On both sides of the border, existing soil mapping projects with rather different strategies and methodologies were used as databases. The objectives for the Slovakian part were:

- Developing a soil map on WRB reference soil group plus one qualifier level
- Mapping parent material according to the European Soil Database
- Mapping texture of topsoil according to FAO guidelines for soil description

In Austria, a dichotomic key for the correlation between the Austrian soil classification and WRB was developed.

The map shows the results of the large scale soil maps semantic harmonisation across the borders of Austria (1:20 000) and Slovakia (1:10 000). The border effect is clearly visible which resulted from different translations of national soil classifications into WRB. Mollic soils from Holocene fluvial sediments are translated as Kastanozems in Austria and as Fluvisols in Slovakia.
Figure 20: Results of a fully harmonized soil map 1:250 000/1:200 000 of the German-French test case covering a south-west German and eastern French window

RESULTS

The test case Germany – France covers a small and physiographically comparable area between Strasbourg (France) and Freiburg im Breisgau (Germany) on the French-German border in the Alsatian region. The Rhine River marks the border between the countries so no edge-matching was required.

The objectives of the French-German test case were:
- Translation of nationally classified soil parameters into FAO classification
- Translation of national soil types into Reference Soil Groups according to WRB
- Presenting translated datasets in a harmonised map

The main outcomes were
- Reporting on the semantic aggregation of map legends and polygons in France
- An investigation of the ‘natural scale’ of the 1:200 000 scale mapping in Germany

From these outcomes, we conclude that one way forward is to allow experts to generalise their legends according to a natural hierarchy such as the Soil Regions of Europe. Further work is required to consolidate the semantic hierarchies in soil classifications in the partner countries into a hierarchical system for Europe.
RESULTS

Three administrative regions of the Bulgarian territory, bordering to Romania: Dobrich, Silistra and Pleven were selected for this test case. The area covers geographic regions which are part of the Danube sub-zone of Chernozems and Fore-Balkan sub-zone of pseudopodzolic soils in northern Bulgaria. By 1988, soils for ca. 80% of Bulgaria were mapped at 1:25 000 scale. The remaining part (mostly agricultural land) was mapped at 1:10 000 scale.

High-resolution maps were used at the Bulgarian side to analyse the variability of soil types for the selected test case areas of Pleven, Dobrich and Silistra to determine the associated soil bodies of mapping units at 1:200 000 scale. This methodically supports steps to work towards a new high-resolution, harmonised European soil data base.
4.6 Complete coverage of neighbouring countries

RESULTS

Typical horizon sequences were derived for a number of extensive soils. Soil attributes crucial for soil classification were derived from the Scottish Soil Database for each horizon. The horizons were classified into WRB diagnostic horizons by a partly automated process and partly by expert judgment. Soil profiles were translated to WRB Reference Soil Group (RSG) and up to two qualifiers using a simplified translation key. A map showing the dominant WRB classification in each 1:250 000 soil map unit.
4. Data harmonisation and exchange

4.7 Principles of data exchange

Europe has a long way to go to develop a common Spatial Data Infrastructure (SDI) supporting policy relevant environmental data use and interpretation across the European Union. European member states represent a great variety of data formats, content definitions, properties, nomenclatures, stratifications, analytical approaches and scales of environmental data. Any kind of cross border – partial or complete EU coverage – soil data interpretation requires the harmonisation and correlation of the content and the spatial geometry of the input data sources. This is called interoperability, meaning that data of different and distributed origin can be discovered, visualized, downloaded, transformed and invoked and interpreted together with other data fulfilling the INSPIRE requirements.

Basic idea of the data exchange is to allow flexibility of using attribute parameters by keeping or gaining interoperability through firstly a generic set of soil related feature types, defined in a feature catalogue. This catalogue is non-extensible in the sense that provider specific feature types are only allowed to be used, if a taxonomic subtype relationship to at least one of the generic feature types defined in the catalogue is explicitly stated. Secondly, interoperability is also ensured using a clear and unambiguous definition of attributes that are added to introduced, provider specific feature types. Both principles should ensure that soil data can be exchanged in an interoperable way, because they define which kind of real world soil objects can be described with attributes, and how these attribute parameters are defined.

INSPIRE intends to achieve a “technical” harmonisation, which enables interoperability of spatial data in web services (D5.1, D5.2, D5.3). Full harmonisation of the conceptual models behind spatial data sets is not required. However, discussion in GS Soil showed that it is sometimes difficult to distinguish between semantic aspects and interoperability. In addition to the abovementioned frame conditions in Europe, GS Soil investigated harmonisation potentials on the nomenclature and classification of data (D4.3). GS Soil offers a unique opportunity to investigate the feasibility of a common nomenclature, and can provide guidance on the effort needed to apply the World Reference Base for Soil Resources as a reference system for classifying soils (in maps).
4.8 Modelling the exchange of soil data

As described above, soil data exist in different formats and national standards across Europe. Principles have been developed in order to exchange soil datasets from basic soil maps, soil profiles and monitoring plots, and soil thematic maps. These principles come with tools to facilitate a comfortable exchange of data (D4.1).

In the framework of Observations and Measurements, the Open Geospatial Consortium (OGC) describes a conceptual model and encoding and serves as a general support for OGC compliant systems. The conceptual models are presented using Unified Modelling Language (UML) class diagrams and in equivalent Geographic Markup Language (GML) as conformant XML representation.

GeoSciML is a standards-based data format that provides a framework for application-neutral encoding of geoscience thematic data and related spatial data. It includes maps, boreholes, and field observations and allows the querying and exchange of digital, interoperable geospatial information between data providers and users. Thus, it allows the communication of data from different formats and different soil content into one comparable content and format.

Soil Markup Language (SoilML) provides the structural framework for the interoperable exchange of individually defined soil related data. The purpose of SoilML is to provide a generic, i.e., top-level classification or conceptual schema for soil data.
Most existing soil data sets come in heterogeneous formats, e.g. as ESRI Shapefiles or GML, with a specific set of attributes for each data set, representing a data provider’s internal data model. Standardised schemas, such as the INSPIRE soil schema, aim for the interoperability of such data sets in defining a common harmonised format. This allows exchanging, combining, and comparing data sets from different sources.

The objective of data transformation is to convert the original data sets to a standardised exchange format, with the semantic harmonisation being applied in the process, resulting in harmonised data sets according to a standardised schema (D4.1). The approach for the transformation used in GS Soil is the definition of schema mappings between the various source schemas and standardised soil schemas. Once a schema mapping is defined, the transformation of corresponding source data can be executed automatically.

The creation of schema mappings is a task for data experts, who are familiar with the semantics and characteristics of their own data and therefore can identify how these relate to the concepts defined in the standardised target schema. To avoid the need for data experts to have detailed technical knowledge about schema mapping and the transformation process, the HUMBOLDT Alignment Editor (HALE) is used as a tool for creating the mappings and executing the resulting transformation on the data (D4.2).

Using HALE the user specifies if and how the concepts defined in source and target schema relate to each other. With every relation being set, the source data loaded in HALE is transformed based on the current overall mapping. This allows the user to compare source and transformed data and to verify if the transformation meets the requirements and expectations. When the mapping is complete, the transformed data can be verified and saved. This ensures the mapping...
being reusable for the transformation of other data sets of the same schema.

In the context of GS Soil HALE has been extended to better support complex target schemas, also support for CSV files and multiple source schemas has been added, and the overall performance and usability has been improved. HALE, including the developments done in GS Soil, is available as free and open source software licensed under the GNU LGPL 3.0. For more information, see http://www.esdi-community.eu/.

Figure 26 + 27: HALE transformation user interface
4. Data harmonisation and exchange

4.10 Best practice implementation

The European Environmental Information Directive (EEID, 2003/4/EC) has been created to improve the public access to environmental information. However, given the fact that spatial and digital environmental data are still provided in different formats they neither match at mapping borders nor have appropriate metadata as supporting information. The same applies to online services. Thus, the GS Soil developments are contributing to the EEID successfully becoming implemented with IN-SPIRE conformant data sets and services provided.

IT terminology was brought together with the soil domain specific terminology intended to develop knowledge and experience related framework for online-based data exchange. Based on the conceptual harmonisation framework, soil information needs to be converted into generic exchange formats. To test and approve the application feasibility of the standardised encoding exchange formats, the GS Soil community provides a large variety of test cases presented in the next chapters. The works on the nine test cases throughout Europe include the following aspects:

1. Description of the data sets and structures (D4.1)
   - mapping unit definitions
   - stratification of the maps
   - data structures (parameters, relationships, nomenclature)

2. Metadata (D3.4)

3. Web Map Services (D5.3, D5.6)

Activities that differ from test case to test case are:

4. Development and testing of XML exchange formats (ISO, SoilML)

5. The selection and export of one or several representative soil profile and analytical data, or estimated soil map profiles in the Web Feature Service

6. Harmonisation aspects such as comparison of map unit definitions, stratification, and WRB

7. Development and testing of transformation services related to portrayal rules

8. The feasibility test to adopt a common theme-specific terminology
For all the national datasets tested in GS Soil (Slovakia, Austria, Germany, France, Ireland, Scotland, Finland, Bulgaria, Romania, Greece, Hungary, Belgium, Denmark, Slovenia) soil property information and database structures are available (D4.1). On this basis, a representative soil conceptual model can now be developed as a basis for the development of a prototype GS Soil application schema. This needs to integrate an overview of existing methodological harmonisation approaches and solutions including the examples from all test cases (D4.3). These achievements will serve as a reference document for the development of INSPIRE data specifications for the theme “Soil” and assured that the basic conceptual model of ISO 25258 Committee Draft of January 2011 is useful. This draft already includes the adaptations from ISO 19156:2011 Geographic information - Observations and Measurements to which the GS Soil consortium has contributed.

With the developments of services and clients within WebGIS Service Oriented Architecture (SOA), the accessibility and processing of data from different sources across borders is enabled, leaving structural and semantic interoperability as open issues to be solved within the soil community and primarily carried out at the data providers’ side. Supposedly, transformation services aid to implement interoperability from the user’s perspective. A primary aspect of technical interoperability is that soil information such as geometric data (mapping units) and other information such as coordinate reference systems must be provided in a coherent way. Attribute data to soil mapping units, soil profile data, or any other point-derived soil measurements, if provided as Web Feature Services, are exchanged following common encoding rules in a common XML format. It is currently discussed as to which level a common domain-specific terminology, thus semantic interoperability, can be achieved. This connects to the issue of harmonisation, which would allow the user to compare and correctly interpret data from different sources.
5. The GS Soil portal

5.1 The unique features of the GS Soil portal

The GS Soil portal is a central access point for end-users to standardised, interoperable and INSPIRE compliant European soil information and delivery website for the finale GS Soil project products (D5.2, D5.3). Via the GS Soil portal, all distributed soil information and data from websites and from viewing services to metadata catalogues are available and accessible at one location. The GS Soil map viewer visualises spatial soil data as OGC and INSPIRE compliant mapping services (WMS and WFS). Iterative cycles adopting the relevant INSPIRE Implementing Rules (Network Services and related) and on the basis of the InGrid software designed for the German Environment Information Portal (PortalU) has been applied towards the final GS Soil portal which is available in 13 languages.

The most important features of the GS Soil portal is the advanced search function to provide access to metadata, soil related websites and publications, dissemination of final project products and best practice examples and the map viewer with direct access to WMS and WFS.

Since one major task of the project was the harmonisation of soil data and provision of public access to these datasets, best practice guidelines were established focusing on the creation and maintenance of data and metadata (D4.3). Examples from those best practice test cases were implemented as view, download, and discovery services in the GS Soil portal.

Figure 29: Picture of the final GS Soil portal entry page
5.2 The portal maps

With the GS Soil map viewer the portal provides access to a variety of soil maps out of the GS Soil inventory on national and regional levels which were provided as INSPIRE view services basing on the OGC Web Map Service (WMS) version 1.3.0 specification.

Technically, first results in the portrayal of different styles via Styled Layer Descriptors (SLD) delivered by the map service and external style information have been achieved. With this function, maps could be displayed with a harmonised or customisable representation.

To permit a user’s direct access to soil data via the map viewer a download module for Web Feature Services (WFS), based on OGC WFS version 1.0.0, and the selection of a spatial filter was developed. With the help of this tool, the user can download XML data directly from the GS Soil portal (Figure 33).

To support the transmission of new WMS to the GS Soil portal a new module was developed. With this module, data providers could submit the information about a new WMS to the portal and thus could add the related topics to each layer.
5. The GS Soil portal

Figure 31: Portrayal of legends for cross-border AT-SK WP4 test case

Figure 32: View of map on data provider side (Geoserver/OpenLayers)
Figure 33: Example of the GS Soil download function
5. The GS Soil portal

5.3 The soil thesaurus and gazetteer

Since soil maps have been created in international settings, national languages are predominant for soil mapping exercises and reporting on soil properties. Additionally, soil and IT experts are joining at the point of making analogue soil maps accessible in a seamless distribution throughout Europe in digital format. Both international soil and IT experts need to speak a common language to ensure proper harmonisation for interoperable spatial datasets (D3.5, D4.1).

Thesauri and ontologies have become state of the art within communities and projects. The European Environmental Agency (EEA) uses and publishes the GEneral Multilingual Environmental Thesaurus (GEMET) which represents a very general environmental vocabulary. This needed an update on more soil specific keywords. Therefore, a soil-specific multilingual thesaurus - the “SoilThes” - has been developed (D3.5). It updates and enhances the GEMET as an extension and contains the soil vocabulary taken from ISO 11074, the concepts of WRB, and concepts created and defined during the GS Soil project.

A gazetteer is a dictionary or directory referencing geographical locations. The important references for information about places and place names have been extracted from the open source products OpenStreetMap (OSM) and the Global Administrative Boundaries Database (GADM). The developed gazetteer contains information on the makeup of a country or region as well as physical features and places such as mountains, waterways, roads, or buildings.

The architectural aspects of the thesaurus and the gazetteer have been linked to the GS Soil portal and are both accessible at no charge. As demanded in the INSPIRE Implementing Rules, SoilThes is syntactically and semantically interoperable with GEMET (D3.4).
5.4 The search functionalities

The search functionality of the portal (D5.3) is directly related to the thesaurus and gazetteer developments and offers the user a large variety of possibilities to find spatial data and information within the GS Soil portal. The “free search” is an easy, “Google-like” way to get information by entering one or more keywords. The query is executed on all available data and information within the portal and lists the results after implementation of a query.

The user can search for information more specifically by using the “advanced search” function. There are the possibilities to confine the results to coordinates, locations, data providers, or time-periods. It is also possible to expand the query by keywords out of a controlled vocabulary, the thesaurus as described before.

A third option for search is the use of the “Thesaurus Browser”. By browsing the hierarchical structure of the thesaurus, it is possible to search for metadata descriptions by keywords.

![Figure 35: Query page of the thesaurus](image-url)
5. The GS Soil portal

5.5 (Meta-) Data and services

The GS Soil portal is a one-stop-shop-portal where users achieve access to different decentralised soil resources with one single query. The catalogues in which the data and services are described using the developed metadata standards are stored locally at the data providers’ disposal. Here the dataset remain updated and maintained and will be distributed on the fly via a Catalogue Service Web (CSW) interface. To allow data providers’ submission of information, GS Soil supports the project partner with two catalogue service solutions (D5.6):

- the GeoNetwork opensource as an open source solution for data providers who want to operate their own infrastructure, and
- the InGridCatalog which is hosted on the GS Soil portal server for data providers with no IT infrastructure.

Both supported catalogue solutions were adopted to the GS Soil metadata profile that was developed within the project for datasets and data series as well as for services (D3.2). The metadata profile used by the GS Soil portal is INSPIRE as well as GS Soil compliant. Besides both solutions provided by GS Soil the existing infrastructure of the partners is supported by harvesting other CSW solutions. They are integrated into the central portal search, too.
5.6 Data access and services

The most valuable service provided by the GS Soil portal is the online access to soil data delivered by different INSPIRE compliant web services and for different data needs. Catalogue Services for the Web (CSW) were used to provide access to soil information via the portal. This is the first step to see the nature of information and data available. Within the map viewer, access to Web Map Service (WMS) and downloadable soil data is offered via a Web Feature Services (WFS).

The data providers are responsible for publishing their INSPIRE compliant catalogue and map services, exposing their data and metadata, into the GS Soil network. These services may be accessed either directly or via the GS Soil portal, the latter option being the one-stop-shop where information from all partners can be consulted in a centralised form.

The data providers elected a package of GeoFOSS (Free and Open Source Software) tools for the usage. However, any software being either FOSS or COTS (COmmercial off The Shelf software) can be used as long as it complies with the OGC and INSPIRE standards, rules and recommendations (D5.6).
5. The GS Soil portal

5.7 Online data provision

One of the main objectives of the GS Soil project was to enable a network of soil data providers to publish their soil information according to established European standards. This data network has been implemented in a decentralised format with the single data provider’s network services connected to a centralised GS Soil portal.

Data providing partners have been helped with setting up GeoServer and GeoNetwork opensource to be able to distribute their datasets to the central GS Soil portal (D5.6).

The GS Soil network also helped partners in documenting and providing information to the centralised metadata catalogue (InGrid) that may be used by the soil data providers that do not have any software infrastructure yet or do not feel comfortable using the elected GS Soil GeoFOSS package mentioned in the previous page. For different partners’ use cases, steps towards the web-based provision of (meta-) datasets have been documented as guidance for those in need to setup similar services outside the GS Soil network.

As already highlighted, soil data provider deliver services and publish content (data and metadata) to the centralised portal. These services are currently divided and available into three categories:

1. Catalogue services: Provide metadata via a CSW harvesting endpoint.
2. View Services: Provide map images, thematic and legends via WMS 1.3.0 (includes SLD).
3. Download Services: Provide the consultation of feature information and the download of GML files via direct download services (WFS).
Figure 39: InGrid Editor to enter metadata for data providers

Figure 40: Portuguese GeoNetwork opensource supplying CSW Services
6. Networking and Clustering

GS Soil was funded as the project type “Best practice network”. The “Work Programme 2008” indicates that: Their objective is to promote the adoption of standards and specifications for making digital content in Europe more accessible and usable by combining the “consensus building and awareness raising” function of a network with the large-scale implementation in real-life context of one or more concrete specifications or standards by its members.”

The most relevant institutions with respect to soil data have been interlinked within GS Soil, namely the European Soil Bureau Network (ESBN), the European Soil Data Centre (ESDAC), the EuroGeoSurveys, the Food and Agriculture Organization (FAO) of the United Nations (UN), the Global Earth Observation System of Systems (GEOSS), and the International Organization for Standardization (ISO).

In addition to the working groups, organisations, and initiatives mentioned before, more than twenty mainly European projects dealing with soil data capturing, harvesting, and distributing have been contacted (D7.4).
6.1 National events

A number of national events were organised in order to update the soil related stakeholder communities about the on-going work of the GS Soil project. As an example among many other national workshops, the “INSPIRE and soil data in Austria” workshop took place in November 2011. At the University of Salzburg, more than 70 participants from Austria and Germany covering all INSPIRE affected organisations including the soil domain attended this event organised by some Austrian GS Soil partners. The focus was laid on challenges, prospects and chances regarding the implementation of the INSPIRE directive with respect to the dedicated chapter “Soil” of the INSPIRE annex III.

Another example on a national seminar is the workshop held by IGCS at the Home of Agriculture on 1st and 2nd of December 2011 in Strasbourg (France). This event was co-organized by the Association for Agricultural Renewal in Alsace (ARAA) and InfoSol unit of INRA Orléans.

National stakeholder workshops were held in the following countries:

Austria, Belgium, Bulgaria, France, Germany, Greece, Hungary, Poland, Portugal
6. Networking and Clustering

6.2 Capacity building

At university level, GS Soil co-organised two summer schools aiming at capacity building in 2010 and 2011. Young researchers at the end of their Master or beginning of their PhD studies learnt about data organisation, distributed data sharing, metadata capturing and the development and use of tools in order to make spatial data accessible and useable for the public.

In 2010, twenty-four participants from twelve countries participated in this event and shared their knowledge with 33 lecturers from ten countries; among them members of the GS Soil consortium. That the topic is strongly interdisciplinary has been underpinned by the eleven disciplines in which participants have been educated.

The Summer School EnviSDI aimed to improve the access to spatial environmental data for public sector bodies, private companies, and citizens. In twelve days, the participants considered aspects of data organisation, data harmonisation as well as semantic and technical interoperability across domains in order to produce seamless geospatial pan-European information and to improve the data access for a wide community of different user groups.
6.3 Sharing expertise

Several institutions and projects have been identified acting in the broader context of the aims of GS Soil. Those institutions were contacted in order to raise awareness of the GS Soil project and to interchange knowledge and general strategies regarding the development of data and services as well as other products and standards related to the soil domain.

Figure 46: Projects and institutions interlinked (extract)
6. Networking and Clustering

6.4 Dissemination and awareness

A lot of effort was made to promote the GS Soil project and its contents to a wider user community. The main means to transport the aims and objectives, the results, and the corporate design of GS Soil to the target user groups were (D7.1):

- the websites http://www.gssoil.eu and http://gssoil-portal.eu (D7.2),
- a project Flyer,
- a logo,
- an USB stick with final deliverables,
- a roll-up,
- a common PPT presentation,
- two GS Soil posters and a poster template for adaptation,
- five Newsletters,
- media presence,
- the final brochure (this brochure D7.3)
- networking and clustering, (D7.4)
- capacity building measures,
- the preparation of workshops and seminars with stakeholders, data providers and users,
- the conference participations (D7.5), and
- an International Innovation Article.

Besides a lot of presentations and posters, more than 25 papers dealing with GS Soil content have been accepted and published in international journals and conference proceedings.
Figure 48: Roll-up, newsletters and publications
7. Outlook

With regard to INSPIRE, it has been demonstrated that the use of the INSPIRE soil application schema would provide interoperable data sets, but would not allow the comparability of its content and resolution across national borders so far. Only if all INSPIRE recommendations would be followed, e.g. providing datasets in FAO soil profile description and WRB classification, and if agreements for aggregation and generalisation of the polygon borders were available (not contained yet in the available ESBN reference material), then the INSPIRE process would provide truly harmonised soil information at higher resolution than that available in the European 1:1 Mio data set.

The existing content framework as developed by the ESBN has been supplemented. The harmonisation activities in the case study areas were directly linked to the best practice recommendations provided as a content framework for providing interoperable and harmonised soil data in Europe. The presentation and the discussion of the results have initiated data harmonisation in the context of the development of a new data layer in Europe. Once data providers follow (voluntarily) a detailed framework for aggregation, and once the harmonisation targets are precisely defined and coupled with national methodologies, then the INSPIRE process would facilitate the development of new products with significant added value for cross-border applications. GS Soil supported this process by a status quo assessment for soil map harmonisation across Europe. Considering the mandatory part of INSPIRE, the provided datasets would be far from being comparable. GS Soil has demonstrated that a substantial amount of national effort is required to refine existing data products using the harmonisation framework developed here. Regarding soil classification, all test cases encountered substantial difficulties to come to reliable and unique classifications (and map legends) using WRB. However, most of them were able to develop and apply pragmatic solutions, at least for the level of the WRB Reference Soil Group (RSG).

As the projects runtime ended in May 2012, efforts have been made to ensure that the results of this project briefly outlined in this brochure are kept available for future use. A solution with the European Soil Data Center and the European Soil Bureau Network is under discussion.
GS Soil has proved that a complex and challenging task can be successfully addressed with joint forces. It has been only an initial step in order to create benefit through the interchange of data, information and knowledge. If you consider yourself as being able to contribute to this aim, we encourage you to contact us.

> http://gssoil-portal.eu <