INSPIRE
Infrastructure for Spatial Information in Europe

D2.8.III.3 Data Specification on SOIL – Draft Guidelines

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Foreword
How to read the document?

This document describes the *"INSPIRE data specification on SOIL – Guidelines"* version 2.0 as developed by the Thematic Working Group (TWG) *Soil* using both natural and a conceptual schema language. This version is now available for the public consultation. Based on the results of the consultation (received comments and the testing reports), the final version 3.0 will be prepared by the TWGs.

The data specification is based on a common template used for all data specifications and has been harmonised using the experience from the development of the Annex I data specifications.

This document provides guidelines for the implementation of the provisions laid down in the draft Implementing Rule for spatial data sets and services of the INSPIRE Directive.

This document includes two executive summaries that provide a quick overview of the INSPIRE data specification process in general, and the content of the data specification on *SOIL* in particular. We highly recommend that managers, decision makers, and all those new to the INSPIRE process and/or information modelling should read these executive summaries first.

The UML diagrams (in Chapter 5) offer a rapid way to see the main elements of the specifications and their relationships. The definition of the spatial object types, attributes, and relationships are included in the Feature Catalogue (also in Chapter 5). People having thematic expertise but not familiar with UML can fully understand the content of the data model focusing on the Feature Catalogue. Users might also find the Feature Catalogue especially useful to check if it contains the data necessary for the applications that they run. The technical details are expected to be of prime interest to those organisations that are/will be responsible for implementing INSPIRE within the field of *SOIL.*

The technical provisions and the underlying concepts are often illustrated by examples. Smaller examples are within the text of the specification, while longer explanatory examples and descriptions of selected use cases are attached in the annexes.

In order to distinguish the INSPIRE spatial data themes from the spatial object types, the INSPIRE spatial data themes are written in *italics.*

The document will be publicly available as a 'non-paper'. It does not represent an official position of the European Commission, and as such cannot be invoked in the context of legal procedures.

Interoperability of Spatial Data Sets and Services – General Executive Summary

The challenges regarding the lack of availability, quality, organisation, accessibility, and sharing of spatial information are common to a large number of policies and activities and are experienced across the various levels of public authority in Europe. In order to solve these problems it is necessary to take measures of coordination between the users and providers of spatial information. The Directive 2007/2/EC of the European Parliament and of the Council adopted on 14 March 2007 aims at establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) for environmental policies, or policies and activities that have an impact on the environment.

INSPIRE will be based on the infrastructures for spatial information that are created and maintained by the Member States. To support the establishment of a European infrastructure, Implementing Rules addressing the following components of the infrastructure are being specified: metadata, interoperability of spatial data themes (as described in Annexes I, II, III of the Directive) and spatial data services, network services and technologies, data and service sharing, and monitoring and reporting procedures.

INSPIRE does not require collection of new data. However, after the period specified in the Directive[1] Member States have to make their data available according to the Implementing Rules.

Interoperability in INSPIRE means the possibility to combine spatial data and services from different sources across the European Community in a consistent way without involving specific efforts of humans or machines. It is important to note that “interoperability” is understood as providing access to spatial data sets through network services, typically via Internet. Interoperability may be achieved by either changing (harmonising) and storing existing data sets or transforming them via services for publication in the INSPIRE infrastructure. It is expected that users will spend less time and efforts on understanding and integrating data when they build their applications based on data delivered within INSPIRE.

In order to benefit from the endeavours of international standardisation bodies and organisations established under international law their standards and technical means have been utilised and referenced, whenever possible.

To facilitate the implementation of INSPIRE, it is important that all stakeholders have the opportunity to participate in specification and development. For this reason, the Commission has put in place a consensus building process involving data users, and providers together with representatives of industry, research and government. These stakeholders, organised through Spatial Data Interest Communities (SDIC) and Legally Mandated Organisations (LMO)[2], have provided reference materials, participated in the user requirement and technical[3] surveys, proposed experts for the Data Specification Drafting Team[4] and Thematic Working Groups[5].

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[1] For all 34 Annex I,II and III data themes: within two years of the adoption of the corresponding Implementing Rules for newly collected and extensively restructured data and within 5 years for other data in electronic format still in use

[2] Number of SDICs and LMOs on 8/6/2011 was 461 and 249 respectively

[3] Surveys on unique identifiers and usage of the elements of the spatial and temporal schema,

[4] The Data Specification Drafting Team has been composed of experts from Austria, Belgium, Czech Republic, France, Germany, Greece, Italy, Netherlands, Norway, Poland, Switzerland, UK, and the European Environmental Agency

[5] The Thematic Working Groups of Annex II and III themes have been composed of experts from Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Netherlands, Norway, Poland, Romania, Slovakia, Spain, Sweden, Switzerland, Turkey, UK, the European Commission, and the European Environmental Agency

This open and participatory approach was successfully used during the development of the data specification on Annex I data themes as well as during the preparation of the Implementing Rule on Interoperability of Spatial Data Sets and Services[6] for Annex I spatial data themes.,

The development framework elaborated by the Data Specification Drafting Team aims at keeping the data specifications of the different themes coherent. It summarises the methodology to be used for the data specifications and provides a coherent set of requirements and recommendations to achieve interoperability. The pillars of the framework are four technical documents:

- The Definition of Annex Themes and Scope[7] describes in greater detail the spatial data themes defined in the Directive, and thus provides a sound starting point for the thematic aspects of the data specification development.

- The Generic Conceptual Model[8] defines the elements necessary for interoperability and data harmonisation including cross-theme issues. It specifies requirements and recommendations with regard to data specification elements of common use, like the spatial and temporal schema, unique identifier management, object referencing, a generic network model, some common code lists, etc. Those requirements of the Generic Conceptual Model that are directly implementable will be included in the Implementing Rule on Interoperability of Spatial Data Sets and Services.

- The Methodology for the Development of Data Specifications[9] defines a repeatable methodology. It describes how to arrive from user requirements to a data specification through a number of steps including use-case development, initial specification development and analysis of analogies and gaps for further specification refinement.

- The "Guidelines for the Encoding of Spatial Data"[10] defines how geographic information can be encoded to enable transfer processes between the systems of the data providers in the Member States. Even though it does not specify a mandatory encoding rule it sets GML (ISO 19136) as the default encoding for INSPIRE.

Based on these framework documents and following the successful development of the Annex I Data specifications (Technical Guidelines) and the Implementing Rules, the new Thematic Working Groups have created the INSPIRE data specification for each Annex II and III theme. These documents – at the version 2.0 – are now publicly available for INSPIRE stakeholders for consultation. The consultation phase covers expert review as well as feasibility and fitness-for-purpose testing of the data specifications.

The structure of the data specifications is based on the "ISO 19131 Geographic information - Data product specifications" standard. They include the technical documentation of the application schema, the spatial object types with their properties, and other specifics of the spatial data themes using natural language as well as a formal conceptual schema language[11].

A consolidated model repository, feature concept dictionary, and glossary are being maintained to support the consistent specification development and potential further reuse of specification elements. The consolidated model consists of the harmonised models of the relevant standards from the ISO 19100 series, the INSPIRE Generic Conceptual Model, and the application schemas[12] developed for

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[6] Commission Regulation (EU) No 1089/2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services, published in the Official Journal of the European Union on 8th of December 2010.

[7] *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.3_Definition_of_Annex_Themes_and_scope_v3.0.pdf*

[8] *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.5_v3.3.pdf*

[9] *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.6_v3.0.pdf*

[10] *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.7_v3.2.pdf*

[11] UML – Unified Modelling Language

[12] Conceptual models related to specific areas (e.g. INSPIRE themes)

each spatial data theme. The multilingual INSPIRE Feature Concept Dictionary contains the definition and description of the INSPIRE themes together with the definition of the spatial object types present in the specification. The INSPIRE Glossary defines all the terms (beyond the spatial object types) necessary for understanding the INSPIRE documentation including the terminology of other components (metadata, network services, data sharing, and monitoring).

By listing a number of requirements and making the necessary recommendations, the data specifications enable full system interoperability across the Member States, within the scope of the application areas targeted by the Directive. They will be published (version 3.0) as technical guidelines and will provide the basis for the content of the Amendment of the Implementing Rule on Interoperability of Spatial Data Sets and Services for data themes included in Annex II and III of the Directive. The Implementing Rule Amendment will be extracted from the data specifications keeping in mind short and medium term feasibility as well as cost-benefit considerations. The Implementing Rule will be legally binding for the Member States.

In addition to providing a basis for the interoperability of spatial data in INSPIRE, the data specification development framework and the thematic data specifications can be reused in other environments at local, regional, national and global level contributing to improvements in the coherence and interoperability of data in spatial data infrastructures.

SOIL – Executive Summary

The Thematic Working Group (TWG) Soil was responsible for developing the data specification on soil. The TWG was composed of 13 experts coming from Belgium, Czech Republic, France, Germany, Italy, Joint Research Centre Ispra, The Netherlands, Norway and Spain.

The INSPIRE Directive (Directive 2007/2/EC) defines Soil as follows: “Soil 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”.
Soil can be considered as a non- renewable resource and fulfils many different (ecosystem) functions.

Based on the definition the scope for the soil theme contains the following elements:

a) **Soil inventories**, providing one-off assessments of soil conditions and/or soil properties at certain locations and at a specific point in time, and **soil monitoring**, providing a series of assessments showing how soil conditions and/or properties change over time.
b) **Soil mapping**, providing a spatial presentation of the properties linked to the soils, including soil types; typically, soil maps are derived with the help of data available in soil inventories
c) **Thematic maps** derived from soil information, possibly in combination with non-soil data.

The following working procedure was followed: from the beginning the TWG Soil focussed on the development of a Model based on expert knowledge and existing international soil data bases and norms. Parallel to that, Use Cases were selected and studied to be able to develop and validate the model.

The present model consists out of a:

- A Core Model containing a core of objects and attributes that are considered to be essential to act as a basis for further INSPIRE legislation.
- Extensions to the Core Model for 4 selected Use Cases: an extension demonstrates how a particular use cases can be implemented starting from the Core Model, by adding objects and attributes.

There are at present very few EU Directives putting strict requirements on soil data. In most cases soil is only involved in an indirect way. Depending on the country, soil related legislation can be present at national level. Some of the national legislation, touching on soil, was established as consequence of EU legislation (for example the Water Frame Work Directive).

During the participative process that happened before the TWG started its work, many stakeholders contributed with User Requirements and Reference Material. During the development of the data specification, a selection of Use Cases were elaborated in detail to develop or validate the model. In total fifteen Use Cases were studied which covered the following fields:

- Agri-Environmental Indicators: 3
- Thematic maps:
    - National legislation 1
    - European use 1
    - National/regional/local use 5
- Contaminated sites
    - National legislation 4
- Soil Monitoring
    - National/regional/local use 1

The data specification has been based, as far as possible on existing standards. Apart from general ISO19xxx standards used in relation to geographical information, use was made of the standards ISO ISO/CD 28258 (Commission Draft/Soil Quality). Since many soil data are captured in the field and analyzed and measured in laboratories, an attempt was made to integrate in the model elements of the upcoming standard DIS ISO 19156:2010 Observation and Measurements.

Since INSPIRE is aiming at interoperability and not necessarily harmonisation we encountered a number of existing harmonisation challenges of which the use of a uniform soil classification is the biggest one.

Acknowledgements

Many individuals and organisations have contributed to the development of these Guidelines.

The Thematic Working Group SOIL (TWG-SO) included:
Arnold Arnoldussen (TWG Facilitator), Stijn Keijers (TWG Editor), Christine Le Bas, Jandirk Bulens (TWG co-editor), Edoardo Constatini, Einar Eberhardt, Patrick Engels, Marc van Liedekerke, Stephan Marahrens, Milan Sanka, Ainara Senar, Kees Versluijs, Robert Tomas (European Commission contact point).

Other contributors to the INSPIRE data specifications are the Drafting Team Data Specifications, the JRC data specifications team and the INSPIRE stakeholders - Spatial Data Interested Communities (SDICs) or Legally Mandated Organisations (LMOs).

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1 Scope

This document specifies a harmonised data specification for the spatial data theme *SOIL* as defined in Annex III of the INSPIRE Directive.

This data specification provides the basis for the drafting of Implementing Rules according to Article 7 (1) of the INSPIRE Directive [Directive 2007/2/EC]. The entire data specification will be published as implementation guidelines accompanying these Implementing Rules.

2 Overview

2.1 Name

INSPIRE data specification for the theme SOIL.

2.2 Informal description

Definition:

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. [Directive 2007/2/EC]

Description:

Broadly seen, soil is the upper part of the earth's crust, formed by mineral particles, organic matter, water, air and living organisms. It is the interface between earth, air and water which hosts most of the biosphere.

Soil is a non-renewable resource which is important for many parts of society. In many places in the world, including Europe, soil degradation is a serious process threatening that soil can fulfil its functions in the future. In the climate change debate soil is becoming important in relation to climate mitigation and adaptation. Soil degradation can have as consequence that soils no longer can fulfil services like food production or that they are that are so contaminated that they form a threat for human and/or ecological health.

Soil is subject to a series of threats as recognized in the EU Soil Thematic Strategy (COM(2006)231 final): erosion, organic matter decline, contamination, salinisation, compaction, soil biodiversity loss, sealing, landslides and flooding. Also soil acidification is generally considered to be a problem. Information on soils is crucial to make informed decisions and to protect the soil against degradation processes.

The need for soil information can vary from improvement of agricultural and forestry production, prevention of environment damage due to human activities, to getting to know the location and extent of contaminated sites and the management of them. There is a high demand for soil information in relation to carbon sequestration (climate change), the prevention of soil degradation and improvement of agricultural production (e.g. food and bio-energy crops).

In order to provide meaningful use and interoperability of information in the field of soil, part of the world of soil (seen as a Universe of Discourse (UoD)) is to be modelled. The soil UoD is defined and limited by considering the problems that need to be solved and the solutions that are to be provided through the use of soil information. The kind of soil information is suggested by Use Cases (preferably underpinned by Legislation) that have been identified by the TWG-SO and by the expertise available in the expert group.

The following use cases are identified and described in Annex B:

- **Agri-Environmental Indicators:**
  - Use Case Environmental Indicator Soil Erosion
  - Use Case Environmental Indicator Soil Quality
  - Use Case Environmental Indicator Contaminated Sites
- **Thematic maps**
  - Land irrigation suitability in Navarra (Spain)
  - Development of methodologies for soil salinity surveillance in the middle Ebro basin (Spain)
  - MARS project
  - Restrictions for N and P in agriculture
  - Calculation threshold trace elements
  - Use of Soil Scape Viewer
  - Establishment Less Favoured Areas (France)
- **Contaminated sites**
  - Contaminated Land Register Austria
  - Use Case drinking water and soil contamination
  - Use Case Ecology and contamination
  - Use Case Property and contamination
- **Soil Monitoring**
  - Use Case state of soil in Europe

To show the relevance of known European legislation related to soil, the Use Cases were cross checked with the legislation at hand; where there is a common interest or overlap on data used, it is indicated in the following table:

Use Cases	***Agri-Environmental Indicators*:**	- Use Case Environmental Indicator Soil Erosion	- Use Case Environmental Indicator Soil Quality	- Use Case Environmental Indicator Contaminated Sites	***Thematic maps***	- Land irrigation suitability in Navarra (Spain)	- Development of methodologies for soil salinity surveillance in the middle Ebro basin (Spain)	- yield forecasting within the MARS project	- Restrictions for N and P in agriculture	- Calculation threshold trace elements	- Use of Soil Scape Viewer	- Establishment Less Favoured Areas (France)	***Contaminated sites***	- Contaminated Land Register Austria	- Use Case drinking water and soil contamination	- Use Case Ecology and contamination	- Use Case Property and contamination	***Soil Monitoring***	- Use Case state of soil in Europe
Directives																			
CAP. Council regulation (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy.						●						●							
Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates form agricultural sources.									●										
Directive 200/60/EC of the European Parliament and of the council of 23 October 2000 establishing a framework for Community action in the field of water policy.									●	●					●				
Directive 2009/28/EC of the European Parliament and of the Council. Energy from renewable resources.												●							
Directive 86/278/EC of the European Parliament and of the Council. Sludge Directive.										●									
Directive 1999/31/EC of the European Parliament and of the Council of 26 April 1999 on the landfill and waste.														●	●	●			
Still under discussion: Less Favoured Areas (LFA) Intermediate areas. This regulation is aimed at better targeting of natural handicap payments COM (2009) 161.												●							
Proposed Soil framework Directive							●							●	●	●	●		

Note that none of the directives is considered as a use case in itself.

Based on the mentioned Use Cases and on the TWG-SO expertise, the following relevant and general uses for soil information were identified:

- For using the spatial distribution of soils and its properties, data that allow the creation of maps (at various scales) of soil types and soil properties are needed. Such data are based on data taken from soil profiles, soil observations and soil samples (taken at soil sites and soil plots), which in combination with human expertise and/or automated procedures can be interpreted such that physical real world areas, which show certain soil characteristics, can be delineated, depending on the scale considered.
- Over time, important soil characteristics (e.g. content of organic carbon, soil acidity, etc.) may vary and it can be required to follow these changes over time; real world 'soil monitoring' is to be included.

- In the context of the EU Soil Thematic Strategy, the problem of soil contamination is a topic that needs to be addressed. To be distinguished are the local scale (the so-called Soil Contaminated Sites), a larger area scale (diffuse soil contamination, usually low level and dispersed by deposition from air, by groundwater or by agricultural practices) and at the level of brownfields (regions with many contaminated sites and usually combined with diffuse contamination).

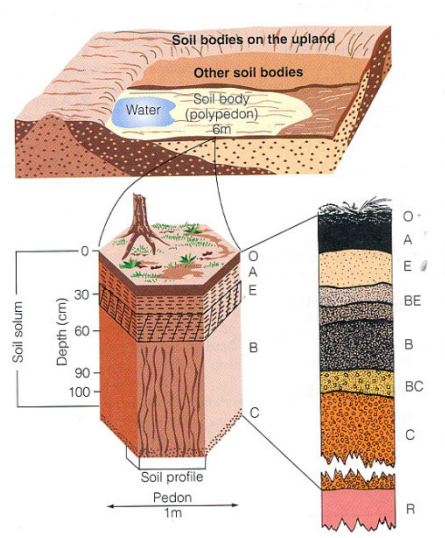
On the basis of the previous considerations, the scope for soil theme includes the following real world phenomena:

- soil profiles
- soil sites, soil plots, soil samples
- soil delineated areas (determination based on certain soil characteristics)
- soil characteristics that change over time (allowing soil monitoring)
- soil contamination

On the basis of these soil real world phenomena, an object model is constructed in the form of a UML class diagram. Information exchange structured according to this model, originating from different providers, will be structurally interoperable and provide a possible way for meaningful exchange of soil information.

This model, which is called ***Core Model,*** consists of a core of objects and attributes that are considered to be essential to act as a basis for further INSPIRE legislation. However, as exemplified by some of the described Use Cases, the objects of the Core Model don't fully allow implementation of certain uses and purposes. The need for modelling of soil data beyond the Core, is accommodated by the possibility of creating extensions to the Core Model. In this document, implementations of extensions are demonstrated for a number of selected Use Cases (on soil erosion, soil contamination, the establishment of Least Favoured Areas, and the state of soil in Europe). Extensions are add-ons to the Core in the form of additional objects and/or attributes.

In the following, the mapping from elements and concepts of the soil domain to model-objects and attributes is described. It should be noted that many elements of the European Soil Geographical Data Base and other international initiatives related to the standardization and exchange of soil data have been taken into account.



Soil Profiles

The real world concept ***"SoilProfile"*** (illustrated by the figure) can be defined as a cross section of the soil from the surface down to and including the beginning of the fresh material unmodified by pedogenesis, consisting of various layers formed by pedogenic processes called horizons. Any real world soil profile can be characterized as a whole by a number of properties, such as: its soil type according to a soil classification scheme, its parent material, coarse fragment cover, and the presence of a water table. Soil horizons within a profile possess biological, physical, chemical (including contamination) characteristics which differ from the horizons above and beneath and are distinguished principally by texture, color, structure, chemical composition, water content and (other) properties. The chemical properties may include concentrations in the solid, water and air phases, mobility and soil adsorption capacities. A profile can additionally be described with layers (instead of being described with horizons) which do not necessarily correspond with pedo-genetically formed layers.

An ***"ObservedSoilProfile"*** represents a soil profile physically located in a soil plot, described in the field, possibly sampled and analyzed in the laboratory. An "observed soil profile" refers to a real world location (specified by an associated soil plot).

A ***"DerivedSoilProfile"*** is a non-soil-plot-located soil profile with property values that are derived (e.g. averaged) from the values of the corresponding properties of one or more "observed soil profiles". The "derived soil profile" is characterized by the same properties, but it is understood that values for these properties have been derived or have been determined by expert judgment or calculation. A "derived soil profile" can be interpreted as a Soil Typological Unit (STU) as recognized in the European Soil Geographical Database other soil databases at national or regional levels.

Soil delineated areas

To delineate spatially a soil cover that can be characterized by a set of such derived soil profiles, the model introduces the construct of ***"SoilComplex"*** which represents an association (or other types of spatial interlinkages of various soil types) of derived soil profiles that are found together in the area. The presence of one or more soils in the soil complex is modelled by indicating which derived soil profiles are present in the soil complex, and to which extent, expressed in percentages or percentage ranges. Note that the exact location of each kind of soil type within the soil complex is unknown; only the area (geometry) of the soil complex is known and also how much of this area is covered by each of the soils (derived profiles), expressed as a range of percentages valid for that area. Typically, a soil complex would consist of one dominant soil (as described by a derived soil profile) and of areas covered by soils having characteristics different from the dominant one. The label of a soil complex allows a description of the soil complex, which may be useful for building legends. A soil complex can be interpreted as a Soil Mapping Unit (SMU) as recognized in the European Soil Geographical Database and other soil databases at national or regional levels.

In the context of the model, a ***"SoilThematicObject"*** is defined as a spatial object representing a soil related property derived from one or more soil properties (and possibly from data external to the soil data

model). It represents values that are derived from data coming from one or more soil complexes, one or more observed soil profiles and/or one or more soil samples. The soil thematic objects are used to derive a soil thematic map.

Soil Site, Soil Plot, Soil Samples
A ***"SoilSite"*** is considered as a wider geographical area where soil investigation takes place in one or more spots, called ***"SoilPlot"***. The purpose of the investigation can be of a general nature (e.g. a reconnaissance whereby soil profiles are taken for a general soil characterization) or specific (e.g. a reconnaissance whereby samples are taken to investigate potentially contaminated land). A soil plot within a soil site is of a certain type (borehole, surface, trial pit, sampling) and located by coordinates and/or the name of that location. A ***"SoilSample"*** (sometimes referred to as specimen) is considered to be a physical part of the soil for which one or more properties are determined.

Soil characteristics that change over time
There are no explicit constructs foreseen related to soil monitoring, but since monitoring is considered as the observation of one or more soil characteristics over time, it can be implemented through the use of the various time/date attributes of the objects of the model.

Soil Contamination
The explicit constructs foreseen related to soil contamination are the contamination attributes of profile horizons and layers, and of soil samples.

2.3 Normative References

[Directive 2007/2/EC] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

[ISO 19107] EN ISO 19107:2005, Geographic Information – Spatial Schema

[ISO 19108] EN ISO 19108:2005, Geographic Information – Temporal Schema

[ISO 19108-c] ISO 19108:2002/Cor 1:2006, Geographic Information – Temporal Schema, Technical Corrigendum 1

[ISO 19111] EN ISO 19111:2007 Geographic information - Spatial referencing by coordinates (ISO 19111:2007)

[ISO 19113] EN ISO 19113:2005, Geographic Information – Quality principles

[ISO 19115] EN ISO 19115:2005, Geographic information – Metadata (ISO 19115:2003)

[ISO 19118] EN ISO 19118:2006, Geographic information – Encoding (ISO 19118:2005)

[ISO 19123] EN ISO 19123:2007, Geographic Information – Schema for coverage geometry and functions

[ISO 19135] EN ISO 19135:2007 Geographic information – Procedures for item registration (ISO 19135:2005)

[ISO 19138] ISO/TS 19138:2006, Geographic Information – Data quality measures

[ISO 19139] ISO/TS 19139:2007, Geographic information – Metadata – XML schema implementation

[OGC 06-103r3] Implementation Specification for Geographic Information - Simple feature access – Part 1: Common Architecture v1.2.0

NOTE This is an updated version of "EN ISO 19125-1:2006, Geographic information – Simple feature access – Part 1: Common architecture". A revision of the EN ISO standard has been proposed.

[Regulation 1205/2008/EC] Regulation 1205/2008/EC implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata

DIS ISI 19156: 2010. Observation and Measurements.

ISO 11074: 2005

ISO 15903: 2002, Soil Quality

ISO 14688 -1 and 2

WD Soil 28258 Soil Quality

2.4 Terms and definitions

General terms and definitions helpful for understanding the INSPIRE data specification documents are defined in the INSPIRE Glossary[13].

2.5 Symbols and abbreviations

CAP	Common Agricultural Policy
CGMS	Crop Growth Monitoring System
CORINE	Coordination of Information on the Environment
DG AGRI	Directorate – General for Agriculture and Rural Development
DG ENV	Directorate – General for Environment
DIS ISO	Draft international standard
DTM	Digital Terrain Model
EC	European Commission
EEA	European Environmental Agency
EIONET	European Environment Information and Observation Network
EMISS	Electromagnetic induction sensing systems
ESBN	European Soil Bureau Network
ESDaC	European Soil Data Center
ETRS89	European Terrestrial Reference System 1989
ETSSP	European Thematic Strategy for Soil Protection
EU	European Union
FAO	Food and Agricultural Organisation
GCM	Global Circulation Model
GIS	Geographical Information System
GML	Geography Mark-up Language
GS Soil	eContentplus project: “Assessment and strategic development of INSPIRE compliant Geodata Services for European Soil data
INSPIRE	Infrastructure for Spatial Information in Europe
IRENA	Indicator reporting on the integration of environmental concerns into agricultural policy
ISO	International Organization for Standardization
ITRS	International Terrestrial Reference System
IUSS	International Union for Soil Associations

[13] The INSPIRE Glossary is available from http://inspire-registry.jrc.ec.europa.eu/registers/GLOSSARY

JRC	Joint Research Centre
LFA	Less Favoured Areas
LMO	Legally Mandated Organisation
MARS	Monitoring Agricultural ResourceS
MCYFS	Crop Yield Forecasting System
NDVI	Normalised Difference Vegetation Index
NUTS	Nomenclature of Units for Territorial Statistics
OM	Organic Matter
PTF	Pedo Transfer Function
RDBMS	Relational Database Management System
RMQS	Réseau de Mesures de la Qualité des Sols
RUSLE	Revised Universal Soil Loss Equation
SCU	Soil Cartographic Unit
SDIC	Spatial Data Interest Community
SFD	Proposed Soil Frame Work Directive
SGDBE	Soil Geographical Data Base for Europe
SLD	Second level domain
SMU	Soil Mapping Unit
SRTM	Shuttle Radar Topography Mission
STU	Soil Typological Unit
TWG	Thematic Working Group (INSPIRE)
TWG SO	Thematic Working Group Soil (INSPIRE)
OCL	Object Constraint Language
O&M	Observations & Measurements
UML	Unified Modelling Language
UN	United Nations
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
USBR	United States Bureau for Reclamation
USDA	United States Department for Agriculture
UTC	Universal Time Coordinated
WFD	Water Frame Work Directive
WRB	World Reference Base for Soil Resources
XML	eXtensible Markup Language

2.6 Notation of requirements and recommendations

To make it easier to identify the mandatory requirements and the recommendations for spatial data sets in the text, they are highlighted and numbered.

IR Requirement X	Requirements that are reflected in the Implementing Rule on interoperability of spatial data sets and services are shown using this style.

DS Requirement X	Requirements that are not reflected in the Implementing Rule on interoperability of spatial data sets and services are shown using this style.

Recommendation 1 Recommendations are shown using this style.

2.7 Conformance

DS Requirement 1	Any dataset claiming conformance with this INSPIRE data specification shall pass the requirements described in the abstract test suite presented in Annex A.

3 Specification scopes

This data specification does not distinguish different specification scopes, but just considers one general scope.

NOTE For more information on specification scopes, see [ISO 19131:2007], clause 8 and Annex D.

4 Identification information

NOTE Since the content of this chapter was redundant with the overview description (section 2) and executive summary, it has been decided that this chapter will be removed in v3.0.

5 Data content and structure

IR Requirement 1	Spatial data sets related to the theme *SOIL* shall be provided using the spatial object types and data types specified in the application schema(s) in this section.

IR Requirement 2	Each spatial object shall comply with all constraints specified for its spatial object type or data types used in values of its properties, respectively.

Recommendation 1	The reason for a void value should be provided where possible using a listed value from the VoidValueReason code list to indicate the reason for the missing value.

NOTEThe application schema specifies requirements on the properties of each spatial object including its multiplicity, domain of valid values, constraints, etc. All properties have to be reported, if the relevant information is part of the data set. Most properties may be reported as “void”, if the data set does not include relevant information. See the Generic Conceptual Model [INSPIRE DS-D2.5] for more details.

5.1 Basic notions

This section explains some of the basic notions used in the INSPIRE application schemas. These explanations are based on the GCM [DS-D2.5].

5.1.1 Stereotypes

In the application schemas in this sections several stereotypes are used that have been defined as part of a UML profile for use in INSPIRE [INSPIRE DS-D2.5]. These are explained in Table 1 below.

Table 1 – Stereotypes (adapted from [INSPIRE DS-D2.5])

Stereotype	Model element	Description
applicationSchema	Package	An INSPIRE application schema according to ISO 19109 and the Generic Conceptual Model.
featureType	Class	A spatial object type.
type	Class	A conceptual, abstract type that is not a spatial object type.
dataType	Class	A structured data type without identity.
union	Class	A structured data type without identity where exactly one of the properties of the type is present in any instance.
enumeration	Class	A fixed list of valid identifiers of named literal values. Attributes of an enumerated type may only take values from this list.
codeList	Class	A flexible enumeration that uses string values for expressing a list of potential values.
placeholder	Class	A placeholder class (see definition in section 5.1.2).
voidable	Attribute, association role	A voidable attribute or association role (see definition in section 5.1.3).
lifeCycleInfo	Attribute, association role	If in an application schema a property is considered to be part of the life-cycle information of a spatial object type, the property shall receive this stereotype.
version	Association role	If in an application schema an association role ends at a spatial object type, this stereotype denotes that the value of the property is meant to be a specific version of the spatial object, not the spatial object in general.

5.1.2 Placeholder and candidate types

Some of the INSPIRE Annex I data specifications (which were developed previously to the current Annex II+III data specifications) refer to types that thematically belong and were expected to be fully specified in Annex II or III spatial data themes. Two kinds of such types were distinguished:

- *Placeholder types* were created as placeholders for types (typically spatial object types) that were to be specified as part of a future spatial data theme, but which was already used as a value type of an attribute or association role in this data specification.

  Placeholder types received the stereotype «placeholder» and were placed in the application schema package of the future spatial data theme where they thematically belong. For each placeholder, a definition was specified based on the requirements of the Annex I theme. The Annex II+III TWGs were required to take into account these definitions in the specification work of the Annex II or III theme.

  If necessary, the attributes or association roles in the Annex I data specification(s) that have a placeholder as a value type shall be updated if necessary.

- *Candidate types* were types (typically spatial object types) for which already a preliminary specification was given in the Annex I data specification. Candidate types did not receive a specific stereotype and were placed in the application schema package of the future spatial data theme where they thematically belong. For each candidate type, a definition and attributes and association roles were specified based on the requirements of the Annex I theme. The Annex II+III TWGs were required to take into account these specifications in the specification work of the Annex II or III theme.

  If the type could not be incorporated in the Annex II or III data specification according to its preliminary specification, it should be moved into the application schema of the Annex I theme

where it had first been specified. In this case, the attributes or association roles in the Annex I data specification(s) that have the type as a value type shall be updated if necessary.

Open issue 1: For all Annex II+III themes for which placeholders and candidate types were specified in an Annex I data specification, it should be clearly indicated in the data specification, how the placeholder and candidate types were taken into account. If the proposed solution would require any changes to an Annex I data specification (and the corresponding section in the IR for interoperability of spatial data sets and services), this should also be clearly indicated.

A thorough investigation of the implications of the proposed changes of candidate types (in particular related to requirements of Annex I maintenance) will have to be performed for v3.0 of the data specifications.

5.1.3 Voidable characteristics

If a characteristic of a spatial object is not present in the spatial data set, but may be present or applicable in the real world, the property shall receive this stereotype.

If and only if a property receives this stereotype, the value of *void* may be used as a value of the property. A *void* value shall imply that no corresponding value is contained in the spatial data set maintained by the data provider or no corresponding value can be derived from existing values at reasonable costs, even though the characteristic may be present or applicable in the real world.

It is possible to qualify a value of void in the data with a reason using the VoidValueReason type. The VoidValueReason type is a code list, which includes the following pre-defined values:

- *Unpopulated*: The characteristic is not part of the dataset maintained by the data provider. However, the characteristic may exist in the real world. For example when the “elevation of the water body above the sea level” has not been included in a dataset containing lake spatial objects, then the reason for a void value of this property would be ‘Unpopulated’. The characteristic receives this value for all objects in the spatial data set.
- *Unknown*: The correct value for the specific spatial object is not known to, and not computable by the data provider. However, a correct value may exist. For example when the “elevation of the water body above the sea level” *of a certain lake* has not been measured, then the reason for a void value of this property would be ‘Unknown’. This value is applied on an object-by-object basis in a spatial data set.

NOTEIt is expected that additional reasons will be identified in the future, in particular to support reasons / special values in coverage ranges.

The «voidable» stereotype does not give any information on whether or not a characteristic exists in the real world. This is expressed using the multiplicity:

- If a characteristic may or may not exist in the real world, its minimum cardinality shall be defined as 0. For example, an if an Address may or may not have a house number, the multiplicity of the corresponding property shall be 0..1.
- If at least one value for a certain characteristic exists in the real world, the minimum cardinality shall be defined as 1. For example, if an Administrative Unit always has at least one name, the multiplicity of the corresponding property shall be 1..*.

In both cases, the «voidable» stereotype can be applied. A value (the real value or void) only needs to be made available for properties that have a minimum cardinality of 1.

5.1.4 Code lists and Enumerations

5.1.4.1. Style

All code lists and enumerations use the following modelling style:

- No initial value, but only the attribute name part, is used.

- The attribute name conforms to the rules for attributes names, i.e. is a lowerCamelCase name. Exceptions are words that consist of all uppercase letters (acronyms).

5.1.4.2. Governance of code lists

Two types of code lists are defined in INSPIRE. These two types are distinguished using the tagged value "extendableByMS" in the UML data model:

- *Code lists that **may not** be extended by Member States.* For these code lists, the tagged value is set to "false". They shall be managed centrally in the INSPIRE code list register, and only values from that register may be used in instance data.
- *Code lists that **may** be extended by Member States.* For these code lists, the tagged value is set to "true".

5.2 Application schema Soil Core Model

5.2.1 Description

5.2.1.1. Narrative description

The major spatial objects that can be distinguished in the Soil Core model are:

- SoilSite
- SoilPlot
- SoilSample
- SoilProfile (including Observed and Derived Profiles)
- ProfileElement (including SoilLayer and SoilHorizon)
- SoilComplex
- SoilThematicObject

Their interrelationship is explained in the following paragraphs.

5.2.1.1.1. Soil Profile, Layer and Horizon

The real world concepts of "observed soil profile" and "derived soil profile" are represented though the classes ObservedSoilProfile and DerivedSoilProfile that are subtypes of the (abstract) class SoilProfile.

An "observed soil profile" represents a geo-referenced soil profile, described in the field, possibly sampled and analyzed in the laboratory.

A "derived soil profile" is a non-point-located soil profile with property values that are derived (e.g. averaged) from the values of the corresponding properties of one or more "observed soil profiles"; eventually, a "derived soil profile" could also be a standalone non-geo-referenced soil profile, not associated to an "observed soil profile" and with property values that are determined by expert knowledge.

Any real world "soil profile" can be characterized as a whole by a number of properties, of which the following are included in the core model: its soil type according to the WRB soil classification scheme and/or any other soil classification scheme, the available water capacity and the (observed or derived) potential root depth. To promote interoperability and when possible, it is recommended to use WRB as a classification scheme. On top of the inspireID, any real world "soil profile" can also be identified by a localIdentifier, which is a character string that allows tagging of the profile object with any information that relates the object to the originating data source.

Any instance of an ObservedSoilProfile is associated to exactly one instance of a soilPlot (see further) from which the soilPlotLocation attribute indicates the position for which the profile is valid, i.e. where it is located on the earth's surface.

Any “soil profile”, whether observed or derived, can be described by horizons and layers. Each horizon and layer can have a number of properties. In the model, layers and horizons are represented by the classes SoiLayer and SoilHorizon which are both subtypes of the (abstract) class ProfileElement. The (abstract) SoilProfile can consist of one or more ProfileElement’s.

A real world horizon or layer is at least characterized by an upper depth and a lower depth, indicating the top and the bottom of the horizon or layer; the corresponding attribute in the (abstract) ProfileElement class is profileElementDepthRange.

The chemical and physical properties of horizons and layers and properties that indicate contamination are modeled respectively through the *chemicalParameters*, *physicalParameters* and *contaminant* attributes.

A horizon is further specified by a horizon name according to the FAO horizon notation scheme and/or any other horizon notation scheme.

A layer is further specified by a layer type name that indicates the kind of layer considered: “topsoil”, “subsoil”, “geogenic” or “depthInterval”; this is modeled through the layerType attribute in the SoilLayer class. If the SoilLayer is of the type "geogenic", it can additionally be described by the following attributes:

- layerGenesis, which is the (non pedogenic) process by which it was formed
- layerRockType, which gives petrographic or lithologic information on the rock type the layer is made up of

Wherever applicable, the soil parameters are of the type Measure which is a type built on the ISO 19103:2005 Schema Language standard. This type allows indicating for each provided value also its unit of measure.

Since a ”derived soil profile” characterizes a distinct type of soil that has been identified and described by attributes specifying the nature and properties of the soil, it can be interpreted as a Soil Typological Unit (STU) as recognized in the European Soil Geographical Database and other soil databases at national or regional levels.

5.2.1.1.2. Soil Complex

To delineate geographically areas with a soil cover that can be characterized by a set of derived soil profiles (or STU’s), the model introduces the construct of SoilComplex which represents an association (or other types of spatial inter-linkages of various soil types) of derived soil profiles that are found together in the area specified by the “*geometry*” attribute of the SoilComplex. The presence of one or more kinds of soil in the SoilComplex is modeled with the association “DerivedProfilePresenceInSoilComplex”, which allows indicating which derived soil profiles are present in the SoilComplex, and to which extent (expressed as a couple of percentages. The couple of percentages gives the flexibility to give a range of percentages to express uncertainty on the presence of the soil type. If only one percentage value is to be used, lower and upper boundaries have identical values.

Typically, a SoilComplex would consist of one dominant soil (as described by a derived soil profile) and of areas covered by soils having characteristics different from the dominant one. A derived soil profile can be used to characterize more than one SoilComplex.

The soilComplexLabel attribute of the SoilComplex allows a description of the SoilComplex, which may be useful for building legends.

Note that although the geometry (polygon area) of the SoilComplex is known and also how much area within it is covered by each of the soils, expressed as a range of percentages in the area, the location of each kind of soil within the SoilComplex is unknown.

5.2.1.1.3. Soil Thematic Object

In the context of the model, a (derived)“soil thematic map” is defined as the geographical representation of a variable with values that are derived from data coming from one or more SoilComplexes, one or more ObservedSoilProfiles and/or one or more soilSamples. The points and/or polygons constituting a (derived) “soil thematic map” are implemented by the SoilThematicObject class.

The *geometry* attribute of the SoilThematicObject indicates the geographical location (e.g. a set of one ore more polygons; e.g. a set of one or more points); *soilThematicResult* attribute holds a value that is valid for the geometry. The *depthRange* attribute indicates the soil depth range for which the thematic value for the polygon is valid.

Because the SoilThematicObject relations with SoilComplex, ObservedSoilProfile and soilSample is “0..*”, the The SoilThematicObject class accommodates also for “soil thematic maps” in which spatial information on a soil property is presented that is **not** related to any of the soil objects in the model.

5.2.1.1.4. Soil Site, Soil Plot

A soil site is considered as a wider geographical area where soil investigation takes place in one or more spots, called soil plots. A site represents often just the geographically not strictly defined environment of the plots. The purpose of this investigation can be general (e.g. taking soil profiles for a general soil characterization) or specific (e.g. sampling to investigate potentially contaminated land). The plot object is included in the model to provide a certain kind of geometry for any soil-related information. A plot within a site is of a certain type (borehole, surface, trial pit, and sampling) and possibly located by a geographical point and/or the name of a location.

To a plot, zero or one soil profile and/or zero or more soil samples can be associated. A soil sample is considered to be part of the soil taken at a depth interval at a soil plot, for which one or more properties are investigated.

A soil site is represented in the model with the “SoilSite” object. Its soilInvestigationPurpose attribute indicates the purpose of investigation: general (soilCharacterizationReconnaissance) or specific (soilContaminationReconnaissance).

A soil plot is represented in the model with the “SoilPlot” object. A “SoilSite” comprises one or more “SoilPlot"s. A soil plot is of a certain type (*soilPlotType*) and its location is indicated by the attribute *soilPlotLocation* which can take the form of either a specific X,Y-location either a description of the location using text or an identifier.

A soil sample is represented in the model with the “SoilSample” object. Its *sampledProperty (one or more)* attribute indicates the property (parameter) that is investigated for the sample. Its *sampledDepthRange* attribute indicates the depth range of the sample. On top of the inspireID, any real world soil sample can also be identified by a localIdentifier, which is a character string that allows tagging of the soilSample object with any information that relates the object to the originating data source.

5.2.1.1.5. Observations

For the data specifications of soil we use the Observations & Measurements standard. The Observations & Measurements standard defines a domain independent, conceptual model for the representation of (spatiotemporal) measurement data. ISO defines an application schema as a conceptual schema for data required by one or more applications. O&M can be used as a generic means to deal with measurements in a standardized way. It means that information on the method used (Process), the property type, the metadata, etc. can be stored associated with the object. The result of the observation is the value or values of the observed or measured property. This can appear as a single value, a series of values or a coverage and more.

In the model all the information related to the observation is considered to be the evidence of the value of the property belonging to the feature of interest. This evidence is associated to the feature if interest. In the soil application schemas all the objects containing observation are associated by the abstract class Feature of Interest to the observation related data. Since the result may vary with the particular property (typed Any) this application schema is not hard typed but soft typed to cover all the possible outcomes. It serves as a pattern to be used in that particular case.

In the annex C Observation and measurements the use of O&M is explained.

5.2.1.2. UML Overview

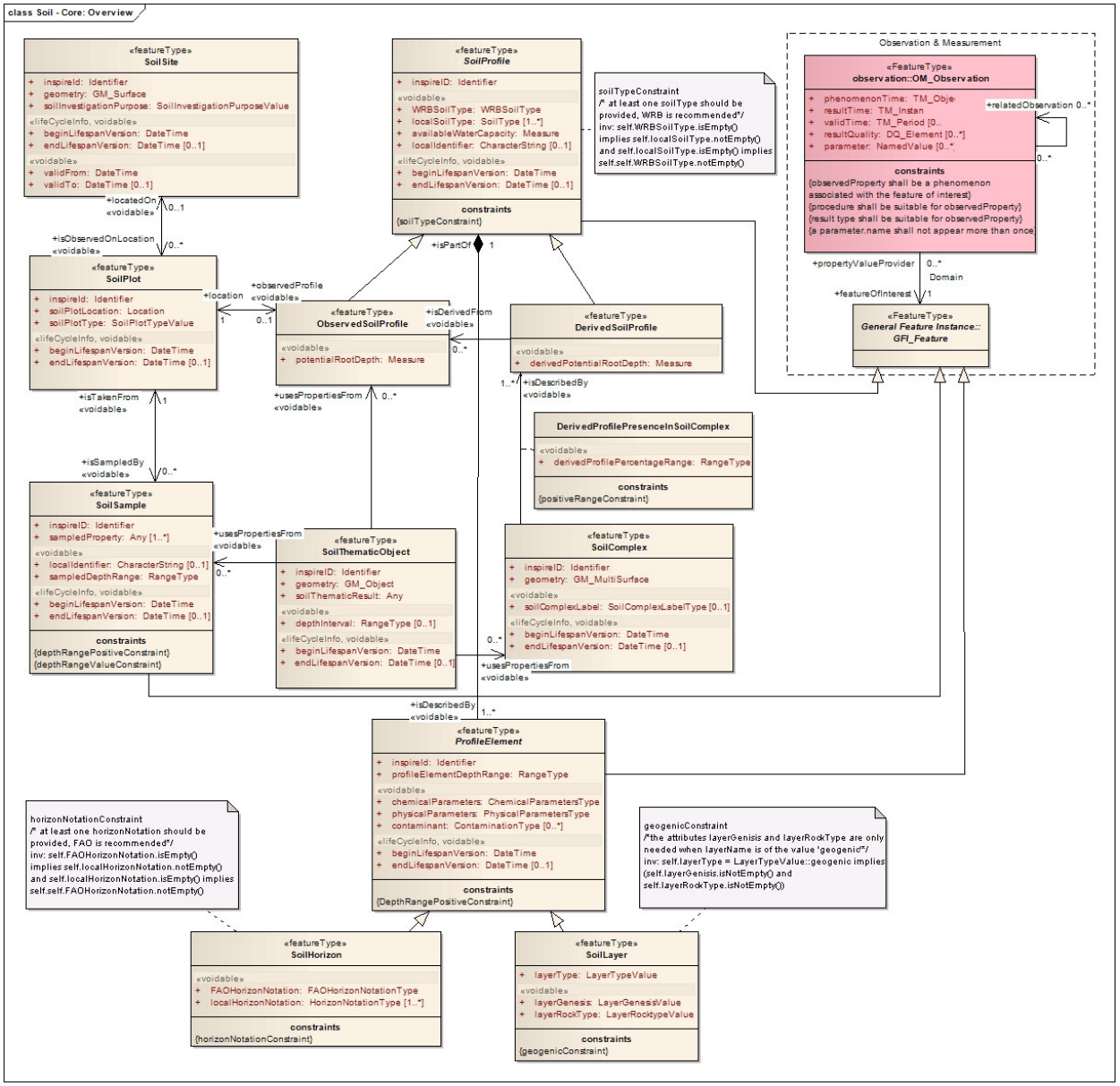


Figure 1 – UML class diagram: Overview of the SOIL CORE application schema

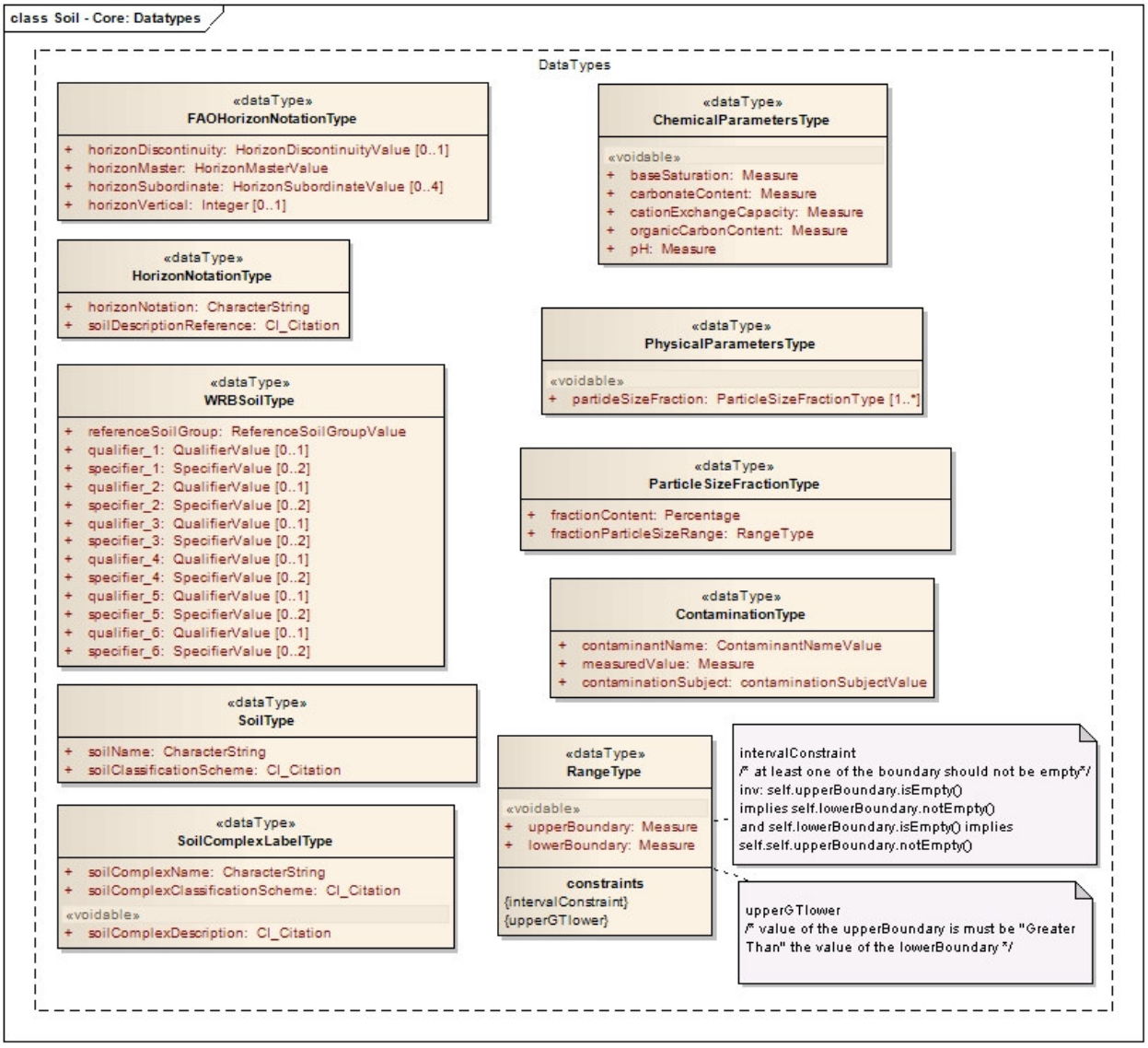


Figure 2 – UML class diagram: SOIL**-CORE Datatypes diagram**

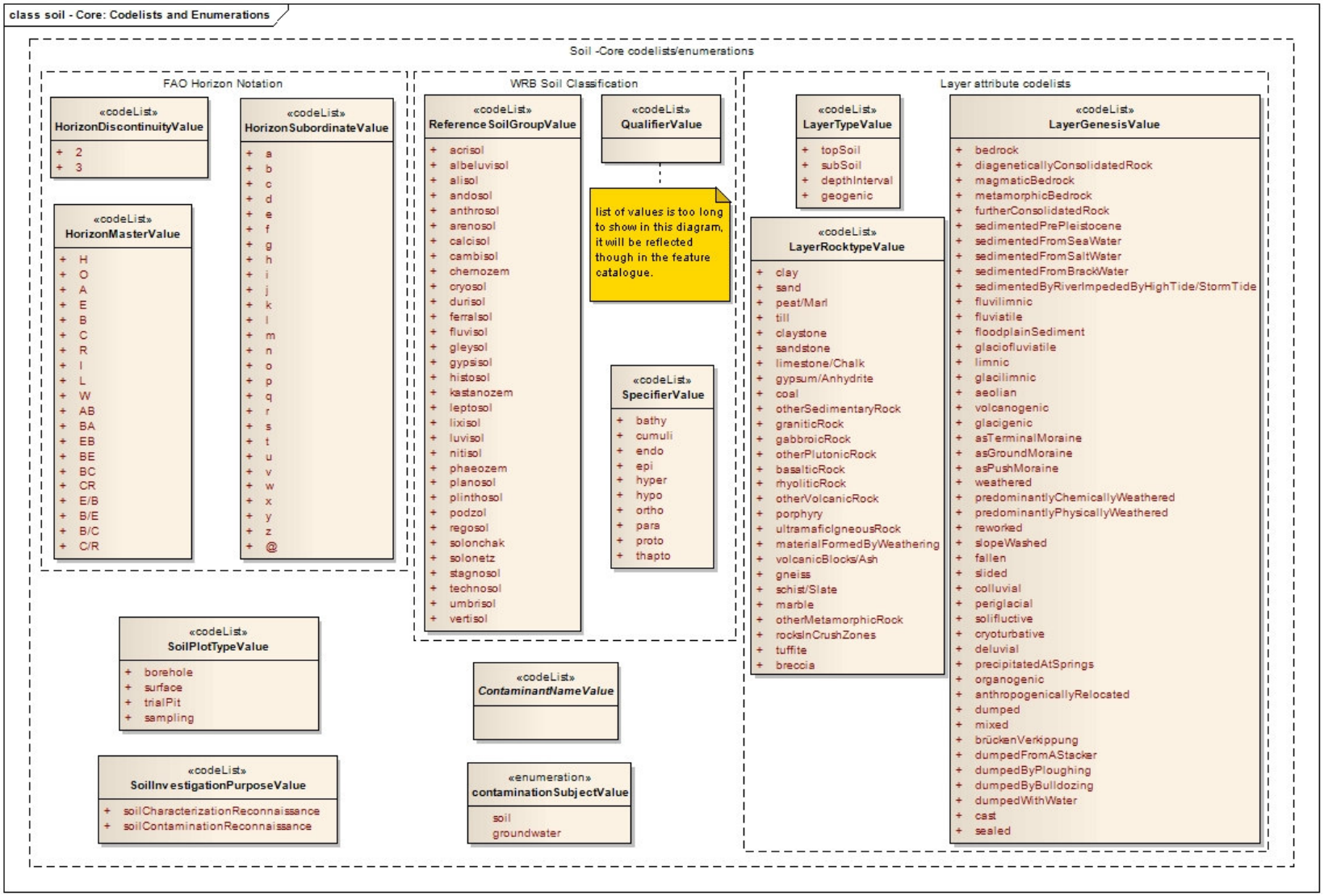


Figure 3 – UML class diagram: SOIL**-CORE codelists and enumerations diagram**

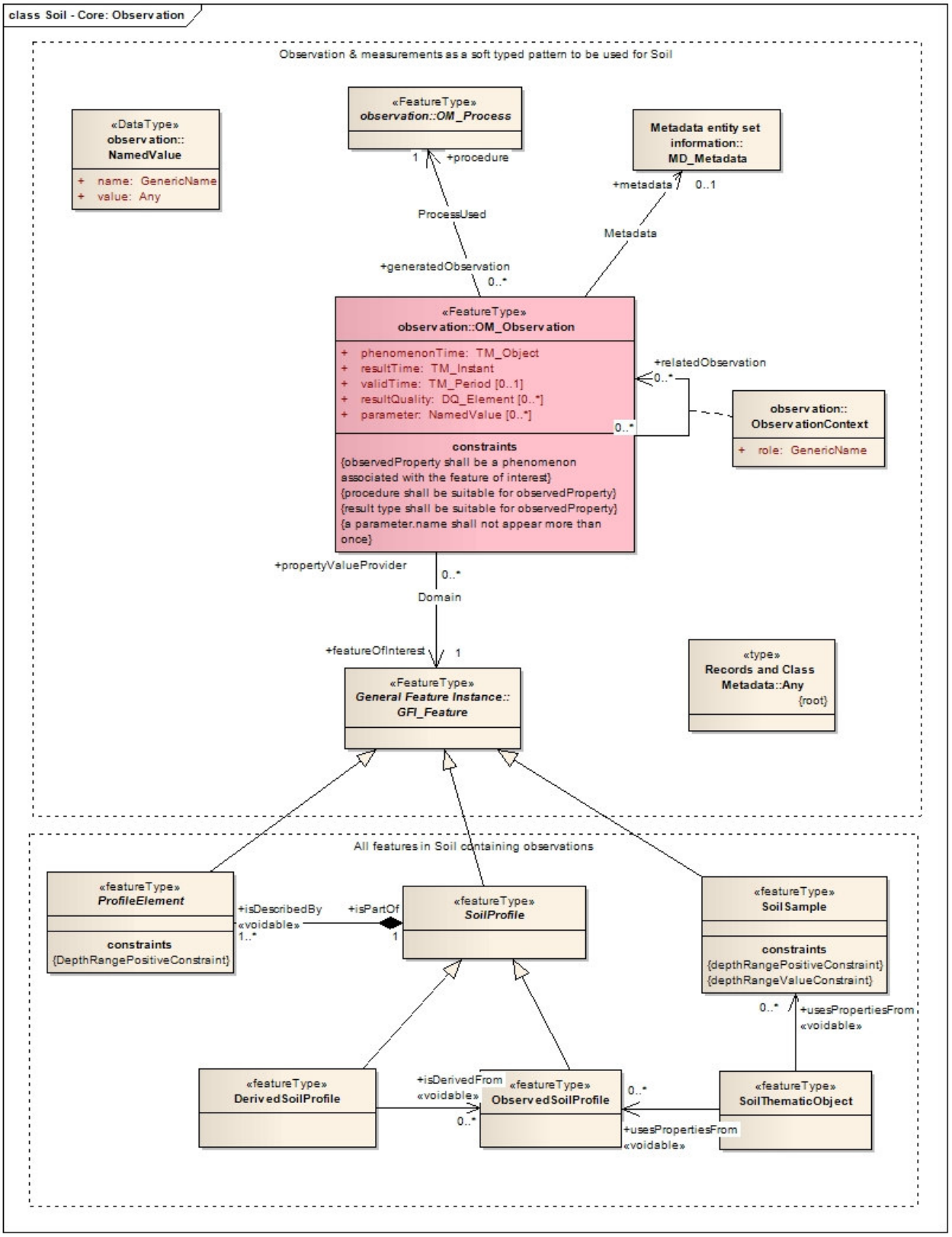


Figure 4 – UML class diagram: SOIL-**CORE Observations & Measurements diagram**

5.2.1.3. Consistency between spatial data sets

The *SOIL* data specification does not define any consistency rules between the spatial data sets.

5.2.1.4. Identifier management

The *SOIL* data specification uses the Identifier dataType from the INSPIRE General Conceptual Model [DS-D2.5]. These identifiers include version number, so can be used to track changes to an object. The use of identifiers in combination with dates is described in more detail in Section 5.2.1.7

5.2.1.5. Modelling of object references *(Optional)*

No specific requirements are needed.

5.2.1.6. Geometry representation *(Optional)*

IR Requirement 3	The value domain of spatial properties used in this specification shall be restricted to the Simple Feature spatial schema as defined by EN ISO 19125-1.

NOTE The specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear.

NOTE The topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

5.2.1.7. Temporality representation *(Optional)*

The application schema(s) use(s) the derived attributes "beginLifespanObject" and "endLifespanObject" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 2	If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.2.2 Feature catalogue

Table 3 - Feature catalogue metadata

Feature catalogue name	INSPIRE feature catalogue Soil - Core
Scope	Soil - Core
Version number	2.0
Version date	2011-06-15
Definition source	INSPIRE data specification Soil - Core

Table 4 - Types defined in the feature catalogue

Type	Package	Stereotypes	Section
ChemicalParametersType	Soil - Core	«dataType»	5.2.2.2.1
ContaminantNameValue	Soil - Core	«codeList»	5.2.2.4.1
ContaminationType	Soil - Core	«dataType»	5.2.2.2.2
DerivedProfilePresenceInSoilComplex	Soil - Core		5.2.2.2.3
DerivedSoilProfile	Soil - Core	«featureType»	5.2.2.1.1
FAOHorizonNotationType	Soil - Core	«dataType»	5.2.2.2.4
HorizonDiscontinuityValue	Soil - Core	«codeList»	5.2.2.4.2
HorizonMasterValue	Soil - Core	«codeList»	5.2.2.4.3
HorizonNotationType	Soil - Core	«dataType»	5.2.2.2.5
HorizonSubordinateValue	Soil - Core	«codeList»	5.2.2.4.4
LayerGenesisValue	Soil - Core	«codeList»	5.2.2.4.5
LayerRocktypeValue	Soil - Core	«codeList»	5.2.2.4.6
LayerTypeValue	Soil - Core	«codeList»	5.2.2.4.7
ObservedSoilProfile	Soil - Core	«featureType»	5.2.2.1.2
ParticleSizeFractionType	Soil - Core	«dataType»	5.2.2.2.6
PhysicalParametersType	Soil - Core	«dataType»	5.2.2.2.7
ProfileElement	Soil - Core	«featureType»	5.2.2.1.3
QualifierValue	Soil - Core	«codeList»	5.2.2.4.8
RangeType	Soil - Core	«dataType»	5.2.2.2.8
ReferenceSoilGroupValue	Soil - Core	«codeList»	5.2.2.4.9
SoilComplex	Soil - Core	«featureType»	5.2.2.1.4
SoilComplexLabelType	Soil - Core	«dataType»	5.2.2.2.9
SoilHorizon	Soil - Core	«featureType»	5.2.2.1.5
SoilInvestigationPurposeValue	Soil - Core	«codeList»	5.2.2.4.10
SoilLayer	Soil - Core	«featureType»	5.2.2.1.6
SoilPlot	Soil - Core	«featureType»	5.2.2.1.7
SoilPlotTypeValue	Soil - Core	«codeList»	5.2.2.4.11
SoilProfile	Soil - Core	«featureType»	5.2.2.1.8
SoilSample	Soil - Core	«featureType»	5.2.2.1.9
SoilSite	Soil - Core	«featureType»	5.2.2.1.10
SoilThematicObject	Soil - Core	«featureType»	5.2.2.1.11
SoilType	Soil - Core	«dataType»	5.2.2.2.10
SpecifierValue	Soil - Core	«codeList»	5.2.2.4.12
WRBSoilType	Soil - Core	«dataType»	5.2.2.2.11
contaminationSubjectValue	Soil - Core	«enumeration»	5.2.2.3.1

5.2.2.1. Spatial object types

5.2.2.1.1. DerivedSoilProfile

DerivedSoilProfile	
Name:	derived soil profile
Subtype of:	GFI_Feature, SoilProfile
Definition:	non-point-located soil profile that serves as a reference profile for a specific soil type in a certain geographical area.
Description:	The characteristics of a derived soil profile are mostly derived (e.g. averaged) from one or several observed profiles of the same soil type in the area of interest, or are designed with expert knowledge about the same kind of landscape. NOTE 1 The derived soil profile represents the average or typical profile that characterises the so called soil typological unit, soil series or soil body.
Status:	Proposed
Stereotypes:	«featureType»
URI:	null

Attribute: derivedPotentialRootDepth

Name	derived potential root depth
Value type:	Measure
Definition:	potential depth of the derived soil profile where roots develop (in cm).
Description:	This depth is based generally on the average of the effective root depths of the observed profiles from which this soil profile is derived. This depth must take in account the presence of obstacle to roots. An obstacle can be: • a toxic layer resulting from low pH values and associated high concentrations of Al and heavy metals, or a high salt content, etc.; • a layer with few oxygen available for plant roots resulting from the presence of permanent or a perched water table, or the presence of a decomposing peat layer, etc; • a hard rock; • an impermeable layer such as a fragipan, an iron pan, clay layers in sediments or as result of pedogenesis.
Multiplicity:	1
Stereotypes:	«voidable»

Association role: isDerivedFrom

Value type:	ObservedSoilProfile
Definition:	a derived soil profile can be derived from many observed soil profiles.
Multiplicity:	0..*
Stereotypes:	«voidable»

5.2.2.1.2. ObservedSoilProfile

ObservedSoilProfile	
Name:	observed soil profile
Subtype of:	GFI_Feature, SoilProfile

ObservedSoilProfile

Definition:	a representation of a soil profile found on a specific location which is described based on observations in a trial pit or a borehole.
Description:	The observed soil profile corresponds to a set of data taken directly from a georeferenced soil profile, described in the field, and often sampled, and analysed in the laboratory.
Status:	Proposed
Stereotypes:	«featureType»
URI:	null

Attribute: potentialRootDepth

Name	potential root depth
Value type:	Measure
Definition:	potential depth of the soil profile where roots develop (in cm).
Description:	This depth must take in account the presence of obstacle to roots. An obstacle can be: • a toxic layer resulting from low pH values and associated high concentrations of Al and heavy metals, or a high salt content, etc.; • a layer with few oxygen available for plant roots resulting from the presence of permanent or a perched water table, or the presence of a decomposing peat layer, etc; • a hard rock; • an impermeable layer such as a fragipan, an iron pan, clay layers in sediments or as result of pedogenesis.
Multiplicity:	1
Stereotypes:	«voidable»

Association role: location

Value type:	SoilPlot
Definition:	the location of an observed profile is the soilplot.
Multiplicity:	1

5.2.2.1.3. ProfileElement

ProfileElement (abstract)

Name:	profile element
Subtype of:	GFI_Feature
Definition:	abstract feature type grouping layers and horizons. Profile element may be considered as a horizontal feature that is parallel to the earth surface and that is part of the profile.
Description:	It is the general term for both horizons and layers.
Status:	Proposed
Stereotypes:	«featureType»
URI:	null

Attribute: beginLifespanVersion

Name	begin lifespan version

ProfileElement (abstract)

Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«lifeCycleInfo,voidable»

Attribute: chemicalParameters

Name	chemical parameters
Value type:	ChemicalParametersType
Definition:	set of relevant quantitative chemical properties of the profile element (layer or horizon).
Description:	soil chemical properties
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: contaminant

Name	contaminant
Value type:	ContaminationType
Definition:	substance or agent present in the profile element as a result of human activity cf. pollutant.
Description:	NOTE: may be heavy metals, and/or organic pollutants EXAMPLE: Dioxin SOURCE ISO 15799:2003
Multiplicity:	0..*
Stereotypes:	«voidable»

Attribute: endLifespanVersion

Name	end lifespan version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«lifeCycleInfo,voidable»

Attribute: inspireId

Name	inspire ID
Value type:	Identifier
Definition:	External object identifier of the soil plot.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1

Attribute: physicalParameters

Name	physical parameters
Value type:	PhysicalParametersType
Definition:	set of relevant qualitative and quantitative physical properties of the profile element (layer or horizon).
Description:	soil physical properties
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: profileElementDepthRange

ProfileElement (abstract)

Name: profile element depth range
Value type: RangeType
Definition: Upper and lower depth of the profile element (layer or horizon) measured from the surface (0 cm) of a soil profile (in cm).
Description: This depth range consist of the average upper and lower depth of appearance of the profile element from the surface.

NOTE Most soil boundaries are zones of transition rather than sharp lines of division.The average depth of the upper boundary and the average depth of the lower boundaries of each horizon are given in centimetres, measured from the surface (including organic and mineral covers) of the soil downwards, i.e. all depth values are positive numbers.
EXAMPLE H horizon 0-5 cm, A horizon 5-30 cm, B horizon 30-80 cm

NOTE Following rules should be taken into account

- lowerBoundary and upperBoundary: should be positive values,
- lowerBoundary is the depth from the top of the element (e.g. 20)
- upperBoundary is the depth of the bottom of the element (e.g. 40)
- lowerBoundary must be smaller than or equal to upperBoundary
- if only lowerBoundary is indicated: it is assumed that the upperBoundary is unknown; this is only possible for the deepest layer or horizon of a profile.
- if only upperBoundary is indicated: it is assumed that the lowerBoundary equals 0, and thus the range is between 0 and the upperBoundary value

Multiplicity: 1

Association role: isPartOf

Value type: SoilProfile
Definition: a profile element is always part of a soil profile.
Multiplicity: 1

Constraint: DepthRangePositiveConstraint

Natural language: lower and upper boundary should be positive values
OCL:

5.2.2.1.4. SoilComplex

SoilComplex

Name: soil complex
Definition: part of the soil cover that is delineated and that is homogeneous with regard to certain soil properties and/or spatial patterns.

SoilComplex

Description:	The soil complex is characterized by a set of derived soil profiles and represents an association (or other type of spatial interlinkage) of various soil types that are found together in the area specified by the “geometry” attribute of the SoilComplex. NOTE 1 These soil types combined to form the soil complex are not spatially defined, but their presence is indicated by a range percentage of area. The underlying reason behind the fact of not delineating the different soil types within a soil complex is the target scale of the map. This means that geographical accuracy and preciseness of soil characterisation depend on and vary with the target scale, i.e. the soil complex can be delineated differently among scales. NOTE 2 The soil complex is also called: mapping unit, soil association, etc.
Status:	Proposed
Stereotypes:	«featureType»
URI:	null

Attribute: beginLifespanVersion

Name	begin lifespan version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«lifeCycleInfo,voidable»

Attribute: endLifespanVersion

Name	end lifespan version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«lifeCycleInfo,voidable»

Attribute: geometry

Name	geometry
Value type:	GM_MultiSurface
Definition:	The geometry defining the boundary of the Soil Complex.
Multiplicity:	1

Attribute: inspireID

Name	inspire id
Value type:	Identifier
Definition:	External object identifier of the soil complex.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1

Attribute: soilComplexLabel

Name	soil complex label
Value type:	SoilComplexLabelType
Definition:	name or name-like description of the soil complex.

SoilComplex

Description:	It's the explanatory legend unit of the map. EXAMPLE Unidad Cartográfica 1: Terrazas altas del Cidacos y del Aragón (70-80 m).
Multiplicity:	0..1
Stereotypes:	«voidable»

Association role: isDescribedBy [the association has additional attributes - see association class DerivedProfilePresenceInSoilComplex]

Value type:	DerivedSoilProfile
Definition:	the derived soil profiles that take part in the Soil Complex.
Multiplicity:	1..*
Stereotypes:	«voidable»

5.2.2.1.5. SoilHorizon

SoilHorizon

Name:	soil horizon
Subtype of:	ProfileElement
Definition:	domain of a soil with a certain vertical extension, which is more or less parallel to the surface and is homogeneous for most morphological and analytical characteristics, developed in a parent material layer through pedogenic processes or made up of in-situ sedimented organic residues of up-growing plants (peat).
Description:	SOURCE ISO/WD 28258 NOTE Horizons may be part of a layer.
Status:	Proposed
Stereotypes:	«featureType»
URI:	null

Attribute: FAOHorizonNotation

Name	FAO horizon notation
Value type:	FAOHorizonNotationType
Definition:	classification of a horizon according to the FAO classification system.
Description:	A code system representing horizons where the same dominant soil forming processes have been active. This code summarizes many observations of the soil description and gives an impression about the genetic processes that have formed the soil under observation. NOTE The horizon notation is a combination of several symbols. SOURCE Guidelines for Soil description. FAO, 2006 EXAMPLE Bw: meaning B horizon with a development of colour and/or structure.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: localHorizonNotation

Name	local horizon notation
Value type:	HorizonNotationType
Definition:	classification of a horizon according to a specific classification system other than FAO.
Description:	A code system representing horizons where the same dominant soil forming processes have been active. This code summarizes many observations of the soil description and gives an impression about the genetic processes that have formed the soil under observation.

SoilHorizon

Multiplicity: 1..*
Stereotypes: «voidable»

Constraint: horizonNotationConstraint

Natural language: at least one horizonNotation should be provided, FAO is recommended
OCL: inv: self.FAOHorizonNotation.isEmpty() implies self.localHorizonNotation.notEmpty() and self.localHorizonNotation.isEmpty() implies self.self.FAOHorizonNotation.notEmpty()

5.2.2.1.6. SoilLayer

SoilLayer

Name: Soil layer
Subtype of: ProfileElement
Definition: domain of a soil with a certain vertical extension developed through non-pedogenic processes, displaying an unconformity to possibly over- or underlying adjacent domains.
Description: NOTE1 Different kinds of layer concepts are covered by this definition.

EXAMPLE 1 Geogenic layers: These are domains, resulting from e.g. sedimentation (as non-pedogenic) processes, that display an unconformity to possibly over- or underlying adjacent domains.

EXAMPLE 2 Topsoil and Subsoil: These can be domains that group different soil horizon types (e.g. A vs. B horizons), or a special case of fixed depths with only two depth ranges (e.g. 0-15 cm: topsoil and, 15-75 cm: subsoil).

EXAMPLE 3 Depth intervals: They are often used in soil monitoring, sampling of contaminated sites and in modelling and include: (i) depth increments (also called fixed depths) that are often used for sampling, e.g. 0-30cm, 30-60cm, and so on, (ii) a single depth range in which a soil sample (”specimen”) is taken and for which the analytical result is valid, and (iii) soil slicing, that is, profile segmentation according to a specified vector, for instance, either regularly spaced intervals (1cm), or a user-defined vector of segment boundaries (i.e. 0-10, 10-25, 25-50, 50-100). Slicing is used in modelling to generate continuous depth functions for soil properties.

EXAMPLE 4: In the framework of soils deeply modified by human activity, artificial layers may be due to different kinds of deposits (concrete, bricks, …). SOURCE WD ISO28258
Status: Proposed
Stereotypes: «featureType»
URI: null

Attribute: layerGenesis

Name: layer genesis
Value type: LayerGenesisValue
Definition: last non-pedogenetic process (geologic or anthropogenic) that coined the material composition and internal structure of the layer.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: layerRockType

Name: layer rock type
Value type: LayerRocktypeValue

SoilLayer

Definition:	type of the material in which the layer developped.
Description:	simplified list of terms to “classify” geologic units
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: layerType

Name	layer type
Value type:	LayerTypeValue
Definition:	classification of a layer according to the concept that fits the purpose.
Description:	EXAMPLE Topsoil: meaning the upper part of the natural soil that is generally dark coloured and has a higher content of organic matter and nutrients when compared to the (mineral) horizons below excluding the humus layer.
Multiplicity:	1

Constraint: geogenicConstraint

Natural language:	the attributes layerGenisis and layerRockType are only needed when layerName is of the value 'geogenic'
OCL:	inv: self.layerType = (LayerTypeValue::geogenic implies self.layerGenisis.isNotEmpty() and self.layerRockType.isNotEmpty()

5.2.2.1.7. SoilPlot

SoilPlot

Name:	soil plot
Definition:	spot where a specific soil investigation is carried out.
Description:	NOTE 1: For observed soil profiles, a spot location has to be defined. It is the place on which the observation is made. The profile is an observation on the plot. NOTE 2: All types of plots only provide locality, but no soil information itself. EXAMPLE A borehole is the location where you gather the information to abstract a profile information from. SOURCE GS Soil
Status:	Proposed
Stereotypes:	«featureType»
URI:	null

Attribute: beginLifespanVersion

Name	begin lifespan version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«lifeCycleInfo,voidable»

Attribute: endLifespanVersion

Name	end lifespan version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«lifeCycleInfo,voidable»

Attribute: inspireId

SoilPlot

Name	inspire ID
Value type:	Identifier
Definition:	External object identifier of the soil plot.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1

Attribute: soilPlotLocation

Name	soil plot location
Value type:	Location
Definition:	a reference to a location on the earth; it can be a point location identified by coordinates or a description of the location using text or an identifier.
Description:	EXAMPLE reference to a place name, municipality or reference to an exact X,Y location
Multiplicity:	1

Attribute: soilPlotType

Name	soil plot type
Value type:	SoilPlotTypeValue
Definition:	gives information on what kind of plot the observation of the soil is made.
Description:	NOTE Trial pits, boreholes or surfaces can be seen as types of soil plots.
Multiplicity:	1

Association role: isSampledBy

Value type:	SoilSample
Definition:	on a Soil Plot several soil samples can be taken to observe one or many soil properties.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: locatedOn

Value type:	SoilSite
Definition:	a soil plot (location of a soil observation) is located on maximum 1 soil site.
Multiplicity:	0..1
Stereotypes:	«voidable»

Association role: observedProfile

Value type:	ObservedSoilProfile
Definition:	a soil plot is the location at which a profile can be observed.
Multiplicity:	0..1
Stereotypes:	«voidable»

5.2.2.1.8. SoilProfile

SoilProfile (abstract)

Name:	soil profile
Subtype of:	GFI_Feature
Definition:	description of the soil that is characterized by a vertical succession of profile elements.
Description:	NOTE The soil profile is abstracted from observations in a trial pit or a boring, or derived from expert knowledge using other soil profiles.
Status:	Proposed

SoilProfile (abstract)

Stereotypes: «featureType»
URI: null

Attribute: WRBSoilType

Name: WRB soil type
Value type: WRBSoilType
Definition: identification of the soil profile according to the WRB 2006 classification schema.
Description: EXAMPLE Lixic Vetic Ferralsol (Ferric, Rhodic) soilClassificationSchema: WRB 2006.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: availableWaterCapacity

Name: available water capacity
Value type: Measure
Definition: amount of water that a soil can store that is usable by plants, based on the effective root penetration depth.
Description: the amount of water that a soil can store that is available for use by plants. It is the water held between field capacity and the wilting point adjusted downward for rock fragments and for salts in solution.

DEFINITION Field capacity: maximum water content expressed in percent (mass fraction or volume fraction), that an unsaturated soil can retain against gravity under undisturbed soil conditions (conventionally stated as the water content 2 to 3 days after full saturation with water).

DEFINITION Wilting point: water content of the soil below which the plants are not able to uptake water with their root system.

SOURCE ISO 11074
Multiplicity: 1
Stereotypes: «voidable»

Attribute: beginLifespanVersion

Name: begin lifespan version
Value type: DateTime
Definition: Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity: 1
Stereotypes: «lifeCycleInfo,voidable»

Attribute: endLifespanVersion

Name: end lifespan version
Value type: DateTime
Definition: Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity: 0..1
Stereotypes: «lifeCycleInfo,voidable»

Attribute: inspireID

Name: inspire ID
Value type: Identifier
Definition: External object identifier of the soil profile.

SoilProfile (abstract)

Description: NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity: 1

Attribute: localIdentifier

Name: profile identifier
Value type: CharacterString
Definition: unique identifier of the soil profile given by the data provider of the dataset.
Multiplicity: 0..1
Stereotypes: «voidable»

Attribute: localSoilType

Name: local soil type
Value type: SoilType
Definition: identification of the soil profile according to a specific classification schema other than WRB 2006.
Multiplicity: 1..*
Stereotypes: «voidable»

Constraint: soilTypeConstraint

Natural language: at least one soilType should be provided, WRB is recommended
OCL: inv: self.WRBSoilType.isEmpty() implies self.localSoilType.notEmpty() and self.localSoilType.isEmpty() implies self.self.WRBSoilType.notEmpty()

5.2.2.1.9. SoilSample

SoilSample

Name: soil sample
Subtype of: GFI_Feature
Definition: certain quantity of soil taken at a specific location and depth from which one or more soil properties will be observed.
Status: Proposed
Stereotypes: «featureType»
URI: null

Attribute: beginLifespanVersion

Name: begin lifespan version
Value type: DateTime
Definition: Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity: 1
Stereotypes: «lifeCycleInfo,voidable»

Attribute: endLifespanVersion

Name: end lifespan version
Value type: DateTime
Definition: Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity: 0..1
Stereotypes: «lifeCycleInfo,voidable»

Attribute: inspireID

SoilSample

Name: inspire ID
Value type: Identifier
Definition: External object identifier of the soil profile.
Description: NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity: 1

Attribute: localIdentifier

Name: profile identifier
Value type: CharacterString
Definition: unique identifier of the soil profile given by the data provider of the dataset.
Multiplicity: 0..1
Stereotypes: «voidable»

Attribute: sampledDepthRange

Name: sampled depth range
Value type: RangeType
Definition: interval that defines the limits of depth (in cm) at which the soil sample is taken.
Description: NOTE Following rules should be taken into account:

- lowerBoundary and upperBoundary: should be positive values,
- lowerBoundary is the depth of the top of the sample (e.g. 20cm)
- upperBoundary is the depth of the bottom of the sample (e.g. 40cm)
- lowerBoundary must be smaller than or equal to upperBoundary
- if lowerBoundary equals upperBoundary: soil sample is taken at a single depth;
- if only lowerBoundary is indicated: it has no meaning
- if only upperBoundary is indicated: it is assumed that the lowerBoundary equals 0, and thus the range is between 0 and the upperBoundary value

Multiplicity: 1
Stereotypes: «voidable»

Attribute: sampledProperty

Name: sampled property
Value type: Any
Definition: any kind of soil property which is the subject of sampling.
Multiplicity: 1..*

Association role: isTakenFrom

SoilSample

Value type:	SoilPlot
Definition:	a soil sample is taken from a location in the field i.e. the soil plot.
Multiplicity:	1
Stereotypes:	«voidable»

Constraint: depthRangePositiveConstraint

Natural language:	lower and upper boundary should be positive values
OCL:	

Constraint: depthRangeValueConstraint

Natural language:	if lowerBoundary is indicated then upperBoundary must not be empty
OCL:	

5.2.2.1.10. SoilSite

SoilSite

Name:	soil site
Definition:	area within a larger survey, study or monitored area, where a specific soil investigation is carried out.
Description:	Site provides the object to describe the surroundings of the plot, date and time information on validity, etc. It is especially used in the inventory of contaminated areas. NOTE Any plot can be linked to one specific site only, but several plots to one site. SOURCE GS Soil
Status:	Proposed
Stereotypes:	«featureType»
URI:	null

Attribute: beginLifespanVersion

Name	begin lifespan version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«lifeCycleInfo,voidable»

Attribute: endLifespanVersion

Name	end lifespan version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«lifeCycleInfo,voidable»

Attribute: geometry

Name	geometry
Value type:	GM_Surface
Definition:	the geometry defining the soil site.
Multiplicity:	1

SoilSite

Attribute: inspireId

Name	inspire ID
Value type:	Identifier
Definition:	External object identifier of the soil site.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1

Attribute: soilInvestigationPurpose

Name	soil investigation purpose
Value type:	SoilInvestigationPurposeValue
Definition:	indicates why an observation is made within a survey.
Description:	Two main purposes are identified to carry out soil surveys. One is to classify the soil as a result of soil forming processes (soil characterization reconnaissance) and the other, to investigate possible contamination as a result of contaminating activities (soil contamination reconnaissance).
Multiplicity:	1

Attribute: validFrom

Name	valid from
Value type:	DateTime
Definition:	date and time from which this version of the spatial object is valid.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: validTo

Name	valid to
Value type:	DateTime
Definition:	date and time until which this version of the spatial object is valid.
Multiplicity:	0..1
Stereotypes:	«voidable»

Association role: isObservedOnLocation

Value type:	SoilPlot
Definition:	a soil site with a specific investigation purpose can be observed on serveral locations (soil plots) inside that site area.
Multiplicity:	0..*
Stereotypes:	«voidable»

5.2.2.1.11. SoilThematicObject

SoilThematicObject

Name:	soil thematic object
Definition:	spatial object representing a soil related property derived from one or more soil properties.
Description:	NOTE Soil thematic maps can be derived directly from the involved soil database (organic matter content, pH, texture, etc.) or they can be derived by using Pedotransfer Functions (water availability…).
Status:	Proposed
Stereotypes:	«featureType»
URI:	null

SoilThematicObject

Attribute: beginLifespanVersion

Name	begin lifespan version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«lifeCycleInfo,voidable»

Attribute: depthInterval

Name	depth interval
Value type:	RangeType
Definition:	range of depth from the surface to which the Soil Thematic Object is referring to.
Description:	A Soil Thematic Object can refer to a soil property for a particular depth range. For example, the texture class from 0 to 30 cm. Thus the DepthRange value will refer to the 0-30 cm depth range.
Multiplicity:	0..1
Stereotypes:	«voidable»

Attribute: endLifespanVersion

Name	end lifespan version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«lifeCycleInfo,voidable»

Attribute: geometry

Name	geometry
Value type:	GM_Object
Definition:	the geometry defining the soil thematic object.
Multiplicity:	1

Attribute: inspireID

Name	inspire ID
Value type:	Identifier
Definition:	external object identifier of the soil thematic object.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1

Attribute: soilThematicResult

Name	soil thematic result/property
Value type:	Any
Definition:	collection of values of the soil related property within the soil thematic object.
Description:	NOTE 1 Soil thematic maps can be derived directly from the involved soil database (organic matter content, pH, texture, etc.) or they can be derived by using Pedotransfer Functions (water availability…). EXAMPLE Land irrigation suitability, pH in the topsoil, etc NOTE 2 one or more values can be associated to the soil thematic object

SoilThematicObject	
Multiplicity:	1
Association role: usesPropertiesFrom	
Value type:	SoilSample
Definition:	a soil thematic object can be created based on the soil properties of (many) soil samples.
Multiplicity:	0..*
Stereotypes:	«voidable»
Association role: usesPropertiesFrom	
Value type:	ObservedSoilProfile
Definition:	a soil thematic object can be created based on the soil properties of (many) observed soil profiles.
Multiplicity:	0..*
Stereotypes:	«voidable»
Association role: usesPropertiesFrom	
Value type:	SoilComplex
Definition:	a soil thematic object can be created based on the soil properties of (many) soil complexes.
Multiplicity:	0..*
Stereotypes:	«voidable»

5.2.2.2. Data types

5.2.2.2.1. ChemicalParametersType

ChemicalParametersType	
Name:	chemical parameters type
Definition:	set of relevant quantitative chemical properties of the profile element (layer or horizon).
Description:	SOURCE Soil survey laboratory information manual version 1.0 EXAMPLE pH values
Status:	Proposed
Stereotypes:	«dataType»
URI:	null
Attribute: baseSaturation	
Name	base saturation
Value type:	Measure
Definition:	the degree of saturation of the adsorption complex of the soil; that is, its occupation by exchangeable basic cations, or cations other than aluminium and hydrogen, expressed as a percentage of the total cation-exchange capacity.
Description:	SOURCE Dictionary of Plant Sciences 1998 http://www.encyclopedia.com/A+Dictionary+of+Plant+Sciences/publications.aspx?pageNumber=1
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: carbonateContent	
Name	carbonate content
Value type:	Measure
Definition:	total calcium carbonate (CaCO3), determined on the <2-mm fine-earth fraction and expressed in a range of percentages.

ChemicalParametersType

Description:	SOURCE Soil survey laboratory information manual version 1.0 pag 109 NOTE it is often measured on a gasvolumetric basis and expressed as calcium carbonate equivalent EXAMPLE percentage value of calcium carbonate equivalent
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: cationExchangeCapacity

Name	cation exchange capacity
Value type:	Measure
Definition:	measure of the quantity of readily exchangeable cations that neutralize negative charges of the soil exchange complex expressed as cmol(+)$100g^{-1}$
Description:	SOURCE Soil survey laboratory information manual version 2.0 pag 121 EXAMPLE 24 centimoles positive charge per 100 g of soil (cmol(+)/100g)
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: organicCarbonContent

Name	organic carbon content
Value type:	Measure
Definition:	portion of the soil measured as carbon in organic forms, including dissolved (DOC: Dissolved Organic Carbon) and total organic compounds (TOC: Total Organic Carbon), expressed in a range of percentages.
Description:	SOURCE 1 ISO 11074:2005 NOTE Organic carbon content can serve as an indirect determination of organic matter through the use of an approximate correction factor. The “Van Bemmelen factor” of 1.724 has been used for many years and is based on the assumption that organic matter contains 58 percent organic carbon. The literature indicates that the proportion of organic C in soil organic matter for a range of soils is highly variable. Any constant factor that is selected is only an approximation. The ecuation for the estimation of the organic matter according to this factor is the following one: OM (%) = 1.724 x OC (%) SOURCE 2 Soil survey laboratory information manual version 2.0
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: pH

Name	pH
Value type:	Measure
Definition:	negative logaritm to the base of 10 of H-ion activity, by using water or dilute salt solution.
Description:	SOURCE Soil survey laboratory information manual version 1.0 (SSL) NOTE SSL 1.0 determines the 1 N KCl pH, the 1 N NaF pH, the 1:1 water pH, and 1:2 CaCl2 pH. The SSL also determines the 0.01 M CaCl2 pH for organic materials, saturated paste pH, and oxidized pH. EXAMPLE pH value at 1:2 soil water ratio
Multiplicity:	1
Stereotypes:	«voidable»

5.2.2.2.2. ContaminationType

ContaminationType

Name:	contaminant type
Definition:	substance or agent present in the profile element as a result of human activity cf. pollutant.

ContaminationType	
Description:	NOTE: may be heavy metals, and/or organic pollutants EXAMPLE: Dioxin SOURCE ISO 15799:2003
Status:	Proposed
Stereotypes:	«dataType»
URI:	null

Attribute: contaminantName	
Name	contaminant name
Value type:	ContaminantNameValue
Definition:	substance or agent present in soil or groundwater layer as a result of human activity cf. pollutant.
Multiplicity:	1

Attribute: contaminationSubject	
Name	contamination subject
Value type:	contaminationSubjectValue
Definition:	medium in which the contamination was measured, it can either be soil or groundwater.
Multiplicity:	1

Attribute: measuredValue	
Name	measured value
Value type:	Measure
Definition:	measured concentration of the contaminant.
Multiplicity:	1

5.2.2.2.3. DerivedProfilePresenceInSoilComplex

DerivedProfilePresenceInSoilComplex (association class)	
Name:	derived profile presence in soil complex
Definition:	indicates the percentages (lower and upper boundary) that the derived profile takes part in the Soil complex.
Description:	NOTE 1 A Soil Complex is a group of derived profiles in a defined geographic area. These derived profiles are not spatially defined, but their presence is indicated by a range of percentages. NOTE 2 The sum of upper/lower boundary parts should not necessarily add up to 100%. NOTE 3 If not a range, but a specific percentage is used then the lower and upper boundary are equal.
Status:	Proposed
URI:	null

Attribute: derivedProfilePercentageRange	
Name	derived profile percentage range
Value type:	RangeType
Definition:	interval that defines the minumim and maximum percentage of the area of the soilcomplex covered by a specific derived soil profile.
Multiplicity:	1
Stereotypes:	«voidable»

Constraint: positiveRangeConstraint

DerivedProfilePresenceInSoilComplex (association class)	
Natural language:	lower and upper boundary should be positive values
OCL:	

5.2.2.2.4. FAOHorizonNotationType

FAOHorizonNotationType	
Name:	horizon notation type
Definition:	classification of a horizon according to FAO classification system.
Description:	A code system representing horizons where the same dominant soil forming processes have been active. This code summarizes many observations of the soil description and gives an impression about the genetic processes that have formed the soil under observation. NOTE The horizon notation according to FAO is a combination of several symbols: • A number that gives information about discontinuities, i.e. the number of materials in which the soil has formed. • One or two capital letters that designate the type of master horizon (or transitional horizon). • Lowercase letters that designate subordinate characteristics of the horizon. • A number that designate vertical subdivisions. EXAMPLE 2Btg1 SOURCE 1 Guidelines for Soil description. FAO, 2006 SOURCE 2 Biosoil project
Status:	Proposed
Stereotypes:	«dataType»
URI:	null

Attribute: horizonDiscontinuity	
Name	horizon discontinuity
Value type:	HorizonDiscontinuityValue
Definition:	number used to indicate a discontinuity in the horizon notation.

FAOHorizonNotationType

Description: When the soil has formed entirely in one kind of material, no number is used (the field is empty). When the soil has formed in several materials:

- The upper part of the soil profile (corresponding to the first material) will be designated without number.
- The part of the soil profile corresponding to the second material will be designated with the number 2.
- The part of the soil profile corresponding to the third material will be designated with the number 3.

Multiplicity: 0..1

Attribute: horizonMaster

Name: horizon master
Value type: HorizonMasterValue
Definition: symbol of the master part of the horizon notation.
Description: NOTE: a non exhaustive list is given SOURCE Guidelines for soil description (4th ed.) FAO 2006 p. 67
Multiplicity: 1

Attribute: horizonSubordinate

Name: horizon subordinate
Value type: HorizonSubordinateValue
Definition: designations of subordinate distinctions and features within the master horizons and layers are based on profile characteristics observable in the field and are applied during the description of the soil at the site.
Description: Lower case letters are used as suffixes to designate specific kinds of master horizons and layers, and other features.

SOURCE Guidelines for soil description (4th ed.) FAO 2006, table 85
Multiplicity: 0..4

Attribute: horizonVertical

Name: horizon vertical
Value type: Integer
Definition: order number of the vertical subdivision in the horizon notation.
Description: the number is used to designate the vertical subdivision of a master horizon on the basis of structure, texture, colour, etc.
The number 1 is used to designate the upper part of the master horizon. The number 2 the part of the master horizon situated below, etc. If there is no vertical subdivision, no number is given.
Multiplicity: 0..1

5.2.2.2.5. HorizonNotationType

HorizonNotationType

Name: horizon notation type
Definition: classification of a horizon according to a specific classification system other than FAO.

HorizonNotationType	
Description:	A code system representing horizons where the same dominant soil forming processes have been active. This code summarizes many observations of the soil description and gives an impression about the genetic processes that have formed the soil under observation.
Status:	Proposed
Stereotypes:	«dataType»
URI:	null

Attribute: horizonNotation	
Name	horizon notation
Value type:	CharacterString
Definition:	notation characterizing the soil horizon according to a specified classification system other than FAO.
Description:	NOTE It is the horizon designation value. EXAMPLE Ap: A horizon which has been ploughed.
Multiplicity:	1

Attribute: soilDescriptionReference	
Name	soil description reference
Value type:	CI_Citation
Definition:	reference to a soil profile description guideline (other than FAO) in which the system of horizon designations is defined.
Multiplicity:	1

5.2.2.2.6. ParticleSizeFractionType

ParticleSizeFractionType	
Name:	particle size fraction type
Definition:	mineral part of the soil, fractioned on the basis of size (diameter), limits of the particles. It is the fine earth fraction. That is, the portion of the soil that passes through a 2 mm diameter sieve opening.
Description:	SOURCE1 Soil survey laboratory information manual version 1.0 SOURCE2 GLOSSARY OF SOIL SCIENCE TERMS NOTE “The term particle-size class is used to characterize the grain-size composition of the whole soil, including both the fine earth and the rock and pararock fragments up to the size of a pedon, but it excludes organic matter and salts more soluble than gypsum” (USDA Soil Taxonomy, 2006, chapter 17)
Status:	Proposed
Stereotypes:	«dataType»
URI:	null

Attribute: fractionContent	
Name	fraction content
Value type:	Percentage
Definition:	percentage of the defined fraction.
Description:	SOURCE Soil survey laboratory information manual version 1.0 NOTE sum of the percentages of all the fractions should be equal to 100 percentage EXAMPLE percentage value (weight/weight)
Multiplicity:	1

Attribute: fractionParticleSizeRange	
Name	fraction particle size range
Value type:	RangeType
Definition:	upper and lower limit of the particle size of the defined fraction (expressed in µm)

ParticleSizeFractionType	
Description:	SOURCE Soil survey laboratory information manual version 1.0 EXAMPLE upper limit = 63µm , lower limit =20µm
Multiplicity:	1

5.2.2.2.7. PhysicalParametersType

PhysicalParametersType	
Name:	physical parameters type
Definition:	set of relevant qualitative and quantitative physical properties of the profile element (layer or horizon).
Description:	soil physical properties EXAMPLE bulk density
Status:	Proposed
Stereotypes:	«dataType»
URI:	null

Attribute: particleSizeFraction

Name	particle size fraction
Value type:	ParticleSizeFractionType
Definition:	mineral part of the soil, fractioned on the basis of size (diameter), limits of the particles. Indicates how fine earth is divided.
Description:	SOURCE Soil survey laboratory information manual version 1.0
Multiplicity:	1..*
Stereotypes:	«voidable»

5.2.2.2.8. RangeType

RangeType	
Name:	range type
Definition:	a range value using upper and lower bounds.
Status:	Proposed
Stereotypes:	«dataType»
URI:	null

Attribute: lowerBoundary

Name	lower boundary
Value type:	Measure
Definition:	value defining the lower limit of a specific property.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: upperBoundary

Name	upper boundary
Value type:	Measure
Definition:	value defining the upper limit of a specific property.
Multiplicity:	1
Stereotypes:	«voidable»

Constraint: intervalConstraint

Natural language:	at least one of the boundary should not be empty
OCL:	inv: self.upperBoundary.isEmpty() implies self.lowerBoundary.notEmpty() and self.lowerBoundary.isEmpty() implies self.self.upperBoundary.notEmpty()

Constraint: upperGTlower

RangeType	
Natural language:	value of the upperBoundary is must be "Greater Than" or "Equal to" the value of the lowerBoundary
OCL:	

5.2.2.2.9. SoilComplexLabelType

SoilComplexLabelType	
Name:	soil complex label type
Definition:	name or name-like description of the soil complex according a specific soil complex classification system.
Description:	It's the explanatory legend unit of the map. EXAMPLE Unidad Cartográfica 1: Terrazas altas del Cidacos y del Aragón (70-80 m).
Status:	Proposed
Stereotypes:	«dataType»
URI:	null

Attribute: soilComplexClassificationScheme	
Name	soil complex classification scheme
Value type:	CI_Citation
Definition:	identification of and reference to the framework according to which the soil complex is defined.
Multiplicity:	1

Attribute: soilComplexDescription	
Name	soil complex description
Value type:	CI_Citation
Definition:	explanatory notes describing the specific soil complex in more detail.
Description:	This kind of information can be found in the accompanying booklet of a soil map or mapping instructions.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: soilComplexName	
Name	soil complex name
Value type:	CharacterString
Definition:	name that identifies the soil complex according to the specified reference framework.
Multiplicity:	1

5.2.2.2.10. SoilType

SoilType	
Name:	local soil type
Definition:	identification of the soil profile according to a specific classification schema other than WRB 2006.
Description:	EXAMPLE Fluventic Haploxerept, according to Soil Taxonomy (USDA 2006).
Status:	Proposed
Stereotypes:	«dataType»
URI:	null

Attribute: soilClassificationScheme	
Name	soil classification scheme
Value type:	CI_Citation
Definition:	the name of the soil classification which is used to classify the soil.

SoilType

Description: EXAMPLE Soil Taxonomy (USDA 2006)
Multiplicity: 1

Attribute: soilName

Name: soil name
Value type: CharacterString
Definition: name of the soil profile according to a specific classification schema other than WRB 2006.
Description: EXAMPLE Fluventic Haploxerept, according to Soil Taxonomy (USDA 2006).
Multiplicity: 1

5.2.2.2.11. WRBSoilType

WRBSoilType

Name: WRB soil type
Definition: identification of the soil profile according to the WRB 2006 classification schema.
Description: EXAMPLE Lixic Vetic Ferralsol (Ferric, Rhodic) soilClassificationSchema: WRB 2006.

NOTE this data type is a simplification of the more complex WRB classification system, this generalisation is also used in the project BIOSOILS.
Status: Proposed
Stereotypes: «dataType»
URI: null

Attribute: qualifier_1

Name: qualifier_1
Value type: QualifierValue
Definition: first adjective describing the reference soil group.
Description: comprises those qualifiers that are typically associated with the Reference Soil Group (RSG) (in order of their importance) and the intergrades to other RSGs (in order of the key). *Typically associated* qualifiers are referred to in the WRB Key to the particular RSGs. *Intergrade* qualifiers are those that reflect important diagnostic criteria of another RSG. The WRB Key will, in that case, dictate the choice of the RSG and the intergrade qualifier will provide the bridge to the other RSG. NOTE Prefix qualifier names are always put before the RSG. SOURCE World reference base for soil reusources 2006.
Multiplicity: 0..1

Attribute: qualifier_2

Name: qualifier_2
Value type: QualifierValue
Definition: second adjective describing the reference soil group.
Description: comprises those qualifiers that are typically associated with the Reference Soil Group (RSG) (in order of their importance) and the intergrades to other RSGs (in order of the key). *Typically associated* qualifiers are referred to in the WRB Key to the particular RSGs. *Intergrade* qualifiers are those that reflect important diagnostic criteria of another RSG. The WRB Key will, in that case, dictate the choice of the RSG and the intergrade qualifier will provide the bridge to the other RSG. NOTE Prefix qualifier names are always put before the RSG. SOURCE World reference base for soil reusources 2006.
Multiplicity: 0..1

Attribute: qualifier_3

WRBSoilType

Name qualifier_3
Value type: QualifierValue
Definition: third adjective describing the reference soil group.
Description: comprises those qualifiers that are typically associated with the Reference Soil Group (RSG) (in order of their importance) and the intergrades to other RSGs (in order of the key). *Typically associated* qualifiers are referred to in the WRB Key to the particular RSGs. *Intergrade* qualifiers are those that reflect important diagnostic criteria of another RSG. The WRB Key will, in that case, dictate the choice of the RSG and the intergrade qualifier will provide the bridge to the other RSG. NOTE Prefix qualifier names are always put before the RSG. SOURCE World reference base for soil reusources 2006.
Multiplicity: 0..1

Attribute: qualifier_4

Name qualifier_4
Value type: QualifierValue
Definition: fourth adjective describing the reference soil group.
Description: comprises those qualifiers that are typically associated with the Reference Soil Group (RSG) (in order of their importance) and the intergrades to other RSGs (in order of the key). *Typically associated* qualifiers are referred to in the WRB Key to the particular RSGs. *Intergrade* qualifiers are those that reflect important diagnostic criteria of another RSG. The WRB Key will, in that case, dictate the choice of the RSG and the intergrade qualifier will provide the bridge to the other RSG. NOTE Prefix qualifier names are always put before the RSG. SOURCE World reference base for soil reusources 2006.
Multiplicity: 0..1

Attribute: qualifier_5

Name qualifier_5
Value type: QualifierValue
Definition: fifth adjective describing the reference soil group.
Description: comprises those qualifiers that are typically associated with the Reference Soil Group (RSG) (in order of their importance) and the intergrades to other RSGs (in order of the key). *Typically associated* qualifiers are referred to in the WRB Key to the particular RSGs. *Intergrade* qualifiers are those that reflect important diagnostic criteria of another RSG. The WRB Key will, in that case, dictate the choice of the RSG and the intergrade qualifier will provide the bridge to the other RSG. NOTE Prefix qualifier names are always put before the RSG. SOURCE World reference base for soil reusources 2006.
Multiplicity: 0..1

Attribute: qualifier_6

Name qualifier_6
Value type: QualifierValue
Definition: sixth adjective describing the reference soil group.

WRBSoilType

Description: comprises those qualifiers that are typically associated with the Reference Soil Group (RSG) (in order of their importance) and the intergrades to other RSGs (in order of the key). *Typically associated* qualifiers are referred to in the WRB Key to the particular RSGs. *Intergrade* qualifiers are those that reflect important diagnostic criteria of another RSG. The WRB Key will, in that case, dictate the choice of the RSG and the intergrade qualifier will provide the bridge to the other RSG. NOTE Prefix qualifier names are always put before the RSG. SOURCE World reference base for soil reusources 2006.

Multiplicity: 0..1

Attribute: referenceSoilGroup

Name: WRB reference soilgroup (RSG)

Value type: ReferenceSoilGroupValue

Definition: first level of classification of the World Reference Base for Soil Resources.

Description: *Reference Soil Groups* are distinguished by the presence (or absence) of specific *diagnostic horizons, properties* and/or *materials.* NOTE The WRB soil classification system comprises 32 different RSGs. SOURCE World reference base for soil resources 2006. EXAMPLE Podzol

Multiplicity: 1

Attribute: specifier_1

Name: specifier_1

Value type: SpecifierValue

Definition: specifier for the adjective 1. Code that indicates the degree of expression of a qualifier or the depth range to which the qualifier applies.

Description: Specifiers may be used to indicate depth of occurrence, or to express the intensity of soil characteristics. EXAMPLE Buried layers can be indicated by the specifier “Thapto”.

NOTE 1 The specifier code is always added after the qualifier code.

NOTE 2 Some specifiers can be combined with each other for one qualifier.

SOURCE World reference base for soil resources 2006.

Multiplicity: 0..2

Attribute: specifier_2

Name: specifier_2

Value type: SpecifierValue

Definition: specifier for the adjective 2. Code that indicates the degree of expression of a qualifier or the depth range to which the qualifier applies.

Description: Specifiers may be used to indicate depth of occurrence, or to express the intensity of soil characteristics. EXAMPLE Buried layers can be indicated by the specifier “Thapto”.

NOTE 1 The specifier code is always added after the qualifier code.

NOTE 2 Some specifiers can be combined with each other for one qualifier.

SOURCE World reference base for soil resources 2006.

Multiplicity: 0..2

Attribute: specifier_3

WRBSoilType

Name: specifier_3
Value type: SpecifierValue
Definition: specifier for the adjective 3. Code that indicates the degree of expression of a qualifier or the depth range to which the qualifier applies.
Description: Specifiers may be used to indicate depth of occurrence, or to express the intensity of soil characteristics.
EXAMPLE Buried layers can be indicated by the specifier “Thapto”.

NOTE 1 The specifier code is always added after the qualifier code.

NOTE 2 Some specifiers can be combined with each other for one qualifier.

SOURCE World reference base for soil resources 2006.
Multiplicity: 0..2

Attribute: specifier_4

Name: specifier_4
Value type: SpecifierValue
Definition: specifier for the adjective 4. Code that indicates the degree of expression of a qualifier or the depth range to which the qualifier applies.
Description: Specifiers may be used to indicate depth of occurrence, or to express the intensity of soil characteristics.
EXAMPLE Buried layers can be indicated by the specifier “Thapto”.

NOTE 1 The specifier code is always added after the qualifier code.

NOTE 2 Some specifiers can be combined with each other for one qualifier.

SOURCE World reference base for soil resources 2006.
Multiplicity: 0..2

Attribute: specifier_5

Name: specifier_5
Value type: SpecifierValue
Definition: specifier for the adjective 5. Code that indicates the degree of expression of a qualifier or the depth range to which the qualifier applies.
Description: Specifiers may be used to indicate depth of occurrence, or to express the intensity of soil characteristics.
EXAMPLE Buried layers can be indicated by the specifier “Thapto”.

NOTE 1 The specifier code is always added after the qualifier code.

NOTE 2 Some specifiers can be combined with each other for one qualifier.

SOURCE World reference base for soil resources 2006.
Multiplicity: 0..2

Attribute: specifier_6

Name: specifier_6
Value type: SpecifierValue
Definition: specifier for the adjective 6. Code that indicates the degree of expression of a qualifier or the depth range to which the qualifier applies.

WRBSoilType	
Description:	Specifiers may be used to indicate depth of occurrence, or to express the intensity of soil characteristics. EXAMPLE Buried layers can be indicated by the specifier “Thapto”. NOTE 1 The specifier code is always added after the qualifier code. NOTE 2 Some specifiers can be combined with each other for one qualifier. SOURCE World reference base for soil resources 2006.
Multiplicity:	0..2

5.2.2.3. Enumerations

5.2.2.3.1. contaminationSubjectValue

contaminationSubjectValue	
Name:	contamination subject value
Definition:	medium in which the contamination was measured, it can either be soil or groundwater.
Status:	Proposed
Stereotypes:	«enumeration»
URI:	null
Value: groundwater	
Definition:	contaminant was measured from the groundwater solution (liquid).
Value: soil	
Definition:	contaminant was measured from the dry soil material.

5.2.2.4. Code lists

5.2.2.4.1. ContaminantNameValue

ContaminantNameValue (abstract)	
Name:	contaminant name value
Definition:	list of possible soil pollutants.
Description:	The values of this codelist depend on the domain and on the specific purposes defined by Member States, Regional or local authorities. Therefore this codelist should be extendable by Domain users and Member States.
Status:	Proposed
Stereotypes:	«codeList»
URI:	null

5.2.2.4.2. HorizonDiscontinuityValue

HorizonDiscontinuityValue	
Name:	horizon discontinuity value
Definition:	list of numbers used to indicate a discontinuity in the horizon designation.
Description:	SOURCE Guidelines for soil description (4th ed.) FAO 2006 p.76-77
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May not be extended by Member States.
URI:	http://inspire-registry.jrc.ec.europa.eu/clr/HorizonDiscontinuityValue
Value: 2	
Definition:	The part of the soil profile corresponding to the second material will be designated with the number 2

HorizonDiscontinuityValue
Value: 3

5.2.2.4.3. HorizonMasterValue

HorizonMasterValue	
Name:	horizon master value
Definition:	codelist of the master part of the horizon designation.
Description:	NOTE: a non exhaustive list is given SOURCE Guidelines for soil description (4th ed.) FAO 2006 p. 67
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May not be extended by Member States.
URI:	http://inspire-registry.jrc.ec.europa.eu/clr/HorizonMasterValue
Value: A	
Name:	A horizon
Definition:	Mineral horizon formed at the surface or below an O horizon, in which all or much of the original structure of the parent material has been obliterated and characterized by one or more of the following: • An accumulation of humified organic matter intimately mixed with the mineral fraction and not displaying properties characteristic of E or B horizons (see below); • Properties resulting from cultivation, pasturing, or similar kinds of disturbance; • A morphology that is different from the underlying B or C horizon, resulting from processes related to its surface position.
Value: AB	
Name:	AB horizon
Definition:	Transitional horizon dominated by properties of one master horizon but having subordinate properties of another.
Description:	Two capital letter symbols are used, such as AB, EB, BE and BC. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. EXAMPLE: an AB horizon has characteristics of both an overlying A horizon and an underlying B horizon, but it is more like the A than like the B. NOTE 1: In some cases, a horizon can be designated as transitional even if one of the master horizons to which it is apparently transitional is not present. A BE horizon may be recognized in a truncated soil if its properties are similar to those of a BE horizon in a soil in which the overlying E horizon has not been removed by erosion. An AB or a BA horizon may be recognized where bedrock underlies the transitional horizon. A BC horizon may be recognized even if no underlying C horizon is present; it is transitional to assumed parent material. A CR horizon can be used for weathered bedrock that can be dug with a spade although roots cannot penetrate except along fracture planes. NOTE 2: The I, L and W symbols are not used in transitional horizon designations.
Value: B	
Name:	B horizon

HorizonMasterValue

Definition: Horizon formed below an A, E, H or O horizon, and in which the dominant features are the obliteration of all or much of the original structure of the parent material, together with one or a combination of the following:

- Illuvial concentration of clay, iron, aluminium, humus, carbonates, gypsum, silica or some combination of these;
- Evidence of removal of carbonates;
- Residual concentration of iron and aluminium oxides;
- Coatings of humus and/or oxides that make the horizon conspicuously lower in value, higher in chroma, or redder in hue than overlying and underlying horizons;
- Alteration that forms silicate clay or liberates oxides or both, and that forms a granular, blocky, or prismatic structure if volume changes accompany changes in moisture content;
- Brittle consistence.

Description: All kinds of B horizons are, or were originally, subsurface horizons. Included as B horizons are layers of illuvial concentration of carbonates, gypsum, or silica (these horizons may or may not be cemented) and brittle horizons that have other evidence of alteration, such as prismatic structure or illuvial accumulation of clay.

Value: B/C

Name: B/C horizon

Definition: horizon in which distinct parts have recognizable properties of two kinds of master horizons are indicated.

Description: two capital letter symbols are used, but the two capital letters are separated by a slash (/), such as E/B, B/E, B/C and C/R. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. Commonly, most of the individual parts of one of the components are surrounded by the other.
NOTE: The I, L and W symbols are not used in transitional horizon designations.

Value: B/E

Name: B/E horizon

Definition: horizon in which distinct parts have recognizable properties of two kinds of master horizons are indicated.

Description: two capital letter symbols are used, but the two capital letters are separated by a slash (/), such as E/B, B/E, B/C and C/R. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. Commonly, most of the individual parts of one of the components are surrounded by the other.
NOTE: The I, L and W symbols are not used in transitional horizon designations.

Value: BA

Name: BA horizon

Definition: Transitional horizon dominated by properties of one master horizon but having subordinate properties of another.

HorizonMasterValue	
Description:	Two capital letter symbols are used, such as AB, EB, BE and BC. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. EXAMPLE: an AB horizon has characteristics of both an overlying A horizon and an underlying B horizon, but it is more like the A than like the B. NOTE 1: In some cases, a horizon can be designated as transitional even if one of the master horizons to which it is apparently transitional is not present. A BE horizon may be recognized in a truncated soil if its properties are similar to those of a BE horizon in a soil in which the overlying E horizon has not been removed by erosion. An AB or a BA horizon may be recognized where bedrock underlies the transitional horizon. A BC horizon may be recognized even if no underlying C horizon is present; it is transitional to assumed parent material. A CR horizon can be used for weathered bedrock that can be dug with a spade although roots cannot penetrate except along fracture planes. NOTE 2: The I, L and W symbols are not used in transitional horizon designations.
Value: BC	
Name:	BC horizon
Definition:	Transitional horizon dominated by properties of one master horizon but having subordinate properties of another.
Description:	Two capital letter symbols are used, such as AB, EB, BE and BC. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. EXAMPLE: an AB horizon has characteristics of both an overlying A horizon and an underlying B horizon, but it is more like the A than like the B. NOTE 1: In some cases, a horizon can be designated as transitional even if one of the master horizons to which it is apparently transitional is not present. A BE horizon may be recognized in a truncated soil if its properties are similar to those of a BE horizon in a soil in which the overlying E horizon has not been removed by erosion. An AB or a BA horizon may be recognized where bedrock underlies the transitional horizon. A BC horizon may be recognized even if no underlying C horizon is present; it is transitional to assumed parent material. A CR horizon can be used for weathered bedrock that can be dug with a spade although roots cannot penetrate except along fracture planes. NOTE 2: The I, L and W symbols are not used in transitional horizon designations.
Value: BE	
Name:	BE horizon
Definition:	Transitional horizon dominated by properties of one master horizon but having subordinate properties of another.

HorizonMasterValue	
Description:	Two capital letter symbols are used, such as AB, EB, BE and BC. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. EXAMPLE: an AB horizon has characteristics of both an overlying A horizon and an underlying B horizon, but it is more like the A than like the B. NOTE 1: In some cases, a horizon can be designated as transitional even if one of the master horizons to which it is apparently transitional is not present. A BE horizon may be recognized in a truncated soil if its properties are similar to those of a BE horizon in a soil in which the overlying E horizon has not been removed by erosion. An AB or a BA horizon may be recognized where bedrock underlies the transitional horizon. A BC horizon may be recognized even if no underlying C horizon is present; it is transitional to assumed parent material. A CR horizon can be used for weathered bedrock that can be dug with a spade although roots cannot penetrate except along fracture planes. NOTE 2: The I, L and W symbols are not used in transitional horizon designations.
Value: C	
Name:	C horizon
Definition:	Horizon, excluding hard bedrock, that is little affected by pedogenetic processes (lacks properties of H, O, A, E, or B horizon).
Description:	The material of C layers may be either like or unlike that from which the soil is presumed to have formed. C horizons may have been modified even if there is no evidence of pedogenesis. NOTE: Plant roots can penetrate C horizons that provide an important growing medium.
Value: C/R	
Name:	C/R horizon
Definition:	horizon in which distinct parts have recognizable properties of two kinds of master horizons are indicated.
Description:	two capital letter symbols are used, but the two capital letters are separated by a slash (/), such as E/B, B/E, B/C and C/R. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. Commonly, most of the individual parts of one of the components are surrounded by the other. NOTE: The I, L and W symbols are not used in transitional horizon designations.
Value: CR	
Name:	CR horizon
Definition:	Transitional horizon dominated by properties of one master horizon but having subordinate properties of another.

HorizonMasterValue

Description:	Two capital letter symbols are used, such as AB, EB, BE and BC. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. EXAMPLE an AB horizon has characteristics of both an overlying A horizon and an underlying B horizon, but it is more like the A than like the B. NOTE 1: In some cases, a horizon can be designated as transitional even if one of the master horizons to which it is apparently transitional is not present. A BE horizon may be recognized in a truncated soil if its properties are similar to those of a BE horizon in a soil in which the overlying E horizon has not been removed by erosion. An AB or a BA horizon may be recognized where bedrock underlies the transitional horizon. A BC horizon may be recognized even if no underlying C horizon is present; it is transitional to assumed parent material. A CR horizon can be used for weathered bedrock that can be dug with a spade although roots cannot penetrate except along fracture planes. NOTE 2: The I, L and W symbols are not used in transitional horizon designations.

Value: E

Name:	E horizon
Definition:	Mineral horizon in which the main feature is the loss of clay, iron, aluminium, or some combination of these, leaving a concentration of silts and sands, and in which all or much of the original structure of the parent material has been obliterated.

Value: E/B

Name:	E/B horizon
Definition:	horizon in which distinct parts have recognizable properties of two kinds of master horizons are indicated.
Description:	two capital letter symbols are used, but the two capital letters are separated by a slash (/), such as E/B, B/E, B/C and C/R. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. Commonly, most of the individual parts of one of the components are surrounded by the other. NOTE: The I, L and W symbols are not used in transitional horizon designations.

Value: EB

Name:	EB horizon
Definition:	Transitional horizon dominated by properties of one master horizon but having subordinate properties of another.
Description:	Two capital letter symbols are used, such as AB, EB, BE and BC. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. EXAMPLE: an AB horizon has characteristics of both an overlying A horizon and an underlying B horizon, but it is more like the A than like the B. NOTE 1: In some cases, a horizon can be designated as transitional even if one of the master horizons to which it is apparently transitional is not present. A BE horizon may be recognized in a truncated soil if its properties are similar to those of a BE horizon in a soil in which the overlying E horizon has not been removed by erosion. An AB or a BA horizon may be recognized where bedrock underlies the transitional horizon. A BC horizon may be recognized even if no underlying C horizon is present; it is transitional to assumed parent material. A CR horizon can be used for weathered bedrock that can be dug with a spade although roots cannot penetrate except along fracture planes. NOTE 2: The I, L and W symbols are not used in transitional horizon designations.

Value: H

HorizonMasterValue

Name: H horizon

Definition: horizon dominated by organic material, formed from accumulations of undecomposed or partially decomposed organic material at the soil surface (which may be under water).

Description: NOTE: All H horizons are saturated with water for prolonged periods or were once saturated but are now drained.

Value: I

Name: I layer

Definition: Ice lenses and wedges that contain at least 75% ice (by volume) and that distinctly separate organic or mineral layers in the soil. In areas affected by permafrost, ice bodies may form lenses of wedges that separate entire soil layers. Where such ice concentrations occur within the depth of soil description, they can be designated as I layer.

Description: In areas affected by permafrost, ice bodies may form lenses of wedges that separate entire soil layers. Where such ice concentrations occur within the depth of soil description, they can be designated as I layer.

Value: L

Name: L layer

Definition: These are sediments deposited in a body of water (subaqueous) composed of both organic and inorganic materials, also known as limnic material. DEFINITION Limnic material is either:

1. deposited by precipitation or through action of aquatic organisms, such as algae or diatoms;
2. derived from underwater and floating aquatic plants and subsequently modified by aquatic animals

SOURCE: USDA Soil Survey Staff, 2003

Description: L layers include coprogenous earth or sedimentary peat (mostly organic), diatomaceous earth (mostly siliceous), and marl (mostly calcareous). The L symbol is not used in transitional horizon designations.

Value: O

Name: O horizon

Definition: horizon dominated by organic material, consisting of undecomposed or partially decomposed litter (such as leaves, needles, twigs, moss, and lichens) that has accumulated on the surface.

Description: it may be on top of either mineral or organic soil. It is not saturated with water for prolonged periods. The mineral fraction of such material is only a small part of the volume of the material and generally is much less than half of the mass.

Value: R

Name: R layer

Definition: hard bedrock underlying the soil.

Value: W

Name: W layer

Definition: water layers in soils or water submerging soils, either permanently or cyclic within the time frame of 24 hours.

HorizonMasterValue	
Description:	Some organic soils float on water. In such cases, the W symbol may be used at the end of the soil description to indicate the floating character. In other cases, shallow water (i.e. water not deeper than 1 m) may cover the soil permanently, as in the case of shallow lakes, or cyclic, as in tidal flats. The symbol W is then used to indicate the depth of submergence at the start of the horizon or layer sequence. The occurrence of tidal water can be indicated by (W).

5.2.2.4.4. HorizonSubordinateValue

HorizonSubordinateValue	
Name:	horizon subordinate value
Definition:	list of designations of subordinate distinctions and features within the master horizons and layers are based on profile characteristics observable in the field and are applied during the description of the soil at the site.
Description:	Lower case letters are used as suffixes to designate specific kinds of master horizons and layers, and other features. SOURCE Guidelines for soil description (4th ed.) FAO 2006, table 85
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May not be extended by Member States.
URI:	http://inspire-registry.jrc.ec.europa.eu/clr/HorizonSubordinateValue
Value: @	
Definition:	evidence of cryoturbation (no restriction).
Value: a	
Definition:	highly decomposed organic material, used in case of H and O horizons.
Value: b	
Definition:	buried genetic horizon, used in case of mineral horizons, not cryoturbated.
Value: c	
Definition:	1. concretions or nodules, used in case of mineral horizons. 2. coprogenous earth, used in case of an L horizon.
Value: d	
Definition:	1. dense horizon (physically root-restrictive), used in case of mineral horizons, not used in combination with m. 2. diatomaceous earth, used in case of an L horizon.
Value: e	
Definition:	moderately decomposed organic material used in case of H and O horizons.
Value: f	
Definition:	frozen soil, not used in combination with I and R horizons.
Value: g	
Definition:	stagnic conditions (no restrictions).
Value: h	
Definition:	accumulation of organic matter in case of mineral horizons.
Value: i	

HorizonSubordinateValue	
Definition:	1. slickensides in case of mineral horizons. 2. slightly decomposed organic material in case of H and O horizons.
Value: j	
Definition:	jarosite accumulation (no restriction).
Value: k	
Definition:	accumulation of pedogenetic carbonates (no restriction).
Value: l	
Definition:	capillary fringe mottling (gleying) (no restriction).
Value: m	
Definition:	1. strong cementation or induration (pedogenetic, massive) used in case of mineral horizons. 2. marl used in case of an L horizon.
Value: n	
Definition:	pedogenetic accumulation of exchangeable sodium (no restriction).
Value: o	
Definition:	residual accumulation of sesquioxides (pedogenetic) (no restriction).
Value: p	
Definition:	ploughing or other human disturbance (no restriction, used for E, B or C as Ap).
Value: q	
Definition:	accumulation of pedogenetic silica (no restriction).
Value: r	
Definition:	strong reduction (no restriction).
Value: s	
Definition:	illuvial accumulation of sesquioxides used in case of B horizons.
Value: t	
Definition:	illuvial accumulation of clay used in case of B and C horizons.
Value: u	
Definition:	urban and other man-made materials used in case of H, O, A, E, B and C horizons.
Value: v	
Definition:	occurence of plinthite (no restriction).
Value: w	
Definition:	development of colour or structure in B horizons.
Value: x	
Definition:	fragipan characteristics (no restriction).
Value: y	

HorizonSubordinateValue	
Definition:	pedogenetic accumulation of gypsum (no restriction).
Value: z	
Definition:	pedogenetic accumulation of salts more soluble than gypsum (no restriction).

5.2.2.4.5. LayerGenesisValue

LayerGenesisValue	
Name:	layer genesis value
Definition:	list of possible values indicating the last non-pedogenetic process (geologic or anthropogenic) that coined the material composition and internal structure of the layer.
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May not be extended by Member States.
URI:	http://inspire-registry.jrc.ec.europa.eu/clr/LayerGenesisValue
Value: aeolian	
Value: anthropogenicallyRelocated	
Value: asGroundMoraine	
Value: asPushMoraine	
Value: asTerminalMoraine	
Value: bedrock	
Value: brückenVerkippung	
Value: cast	
Value: colluvial	
Value: cryoturbative	
Value: deluvial	
Value: diageneticallyConsolidatedRock	
Value: dumped	

LayerGenesisValue
Value: dumpedByBulldozing
Value: dumpedByPloughing
Value: dumpedFromAStacker
Value: dumpedWithWater
Value: fallen
Value: floodplainSediment
Value: fluviatile
Value: fluvilimnic
Value: furtherConsolidatedRock
Value: glacigenic
Value: glacilimnic
Value: glaciofluviatile
Value: limnic
Value: magmaticBedrock
Value: metamorphicBedrock
Value: mixed
Value: organogenic

LayerGenesisValue
Value: periglacial
Value: precipitatedAtSprings
Value: predominantlyChemicallyWeathered
Value: predominantlyPhysicallyWeathered
Value: reworked
Value: sealed
Value: sedimentedByRiverImpededByHighTide/StormTide
Value: sedimentedFromBrackWater
Value: sedimentedFromSaltWater
Value: sedimentedFromSeaWater
Value: sedimentedPrePleistocene
Value: slided
Value: slopeWashed
Value: solifluctive
Value: volcanogenic
Value: weathered

5.2.2.4.6. LayerRocktypeValue

LayerRocktypeValue
Name: layer rock type value

LayerRocktypeValue

Definition:	type of the material in which the layer developped.
Description:	simplified list of terms to “classify” geologic units
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May not be extended by Member States.
URI:	http://inspire-registry.jrc.ec.europa.eu/clr/LayerRockTypeValue

Value: basalticRock

Value: breccia

Value: clay

Value: claystone

Value: coal

Value: gabbroicRock

Value: gneiss

Value: graniticRock

Value: gypsum/Anhydrite

Value: limestone/Chalk

Value: marble

Value: materialFormedByWeathering

Value: otherMetamorphicRock

Value: otherPlutonicRock

Value: otherSedimentaryRock

Value: otherVolcanicRock

LayerRocktypeValue
Value: peat/Marl
Value: porphyry
Value: rhyoliticRock
Value: rocksInCrushZones
Value: sand
Value: sandstone
Value: schist/Slate
Value: till
Value: tuffite
Value: ultramaficIgneousRock
Value: volcanicBlocks/Ash

5.2.2.4.7. LayerTypeValue

LayerTypeValue	
Name:	layer type value
Definition:	classification of a layer according to the concept that fits the purpose.
Description:	EXAMPLE Topsoil: meaning the upper part of the natural soil that is generally dark coloured and has a higher content of organic matter and nutrients when compared to the (mineral) horizons below excluding the humus layer.
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May not be extended by Member States.
URI:	http://inspire-registry.jrc.ec.europa.eu/clr/LayerTypeValue
Value: depthInterval	
Name:	depth interval
Definition:	fixed depth range where soil is described and/or samples are taken.

LayerTypeValue	
Description:	They are often used in soil monitoring, sampling of contaminated sites and in modelling, and include: • depth increments (also called fixed depths), that are often used for sampling, e.g. 0-30cm, 30-60cm, and so on, • a single depth range in which a soil sample is taken and for which the analytical result is valid, and • soil slicing, that is, profile segmentation according to a specified vector, for instance, either regularly spaced intervals (1cm), or a user-defined vector of segment boundaries (i.e. 0-10, 10-25, 25-50, 50-100). Slicing is used in modelling to generate continuous depth functions for soil properties.
Value: geogenic	
Name:	geogenic
Definition:	domain resulting from e.g. sedimentation (as non-pedogenic) processes, that display an unconformity to possible over- or underlying adjacent domains.
Value: subSoil	
Name:	sub soil
Definition:	natural soil material below the topsoil and overlying the unweathered parent material.
Description:	SOURCE ISO 11074 NOTE The subsoil can be: (i) a grouping of one to several horizons underlying the horizons with recent humus accumulation from humifying biomass or (ii) a domain of a soil with a specific vertical extension starting well below the soil surface (e.g. 15-75 cm).
Value: topSoil	
Name:	top soil
Definition:	upper part of a natural soil that is generally dark coloured and has a higher content of organic matter and nutrients when compared to the (mineral) horizons below excluding the humus layer.
Description:	NOTE 1 For arable lands, topsoil refers to the ploughed soil depth; for grasslands, it is the soil layer with high root content. NOTE 2 The topsoil can be: (i) a grouping of one to several A horizons or (ii) a domain of a soil with a specific vertical extension starting from the surface (e.g. 0-15 cm). NOTE 3 In most soil description guidelines, the topsoil is composed of all A horizons occurring in a soil profile.

5.2.2.4.8. QualifierValue

QualifierValue	
Name:	WRB qualifiers
Definition:	list of possible qualifiers (i.e. prefix and suffix qualifiers of the World Reference Base for Soil Resources).
Description:	SOURCE World reference base for soil resources 2006.

QualifierValue
Status: Proposed Stereotypes: «codeList» Governance: May not be extended by Member States. URI: http://inspire-registry.jrc.ec.europa.eu/clr/QualifierValue
Value: abruptic
Value: aceric
Value: acric
Value: acrisolic
Value: acroxic
Value: albeluvisolic
Value: albic
Value: alcalic
Value: alic
Value: alisolic
Value: aluandic
Value: alumic
Value: andic
Value: andosolic
Value: anthraquic
Value: anthric

QualifierValue
Value: anthrosolic
Value: arenic
Value: arenosolic
Value: aric
Value: aridic
Value: arzic
Value: brunic
Value: calcaric
Value: calcic
Value: calcisolic
Value: cambic
Value: cambisolic
Value: carbic
Value: carbonatic
Value: chernozemic
Value: chloridic
Value: chromic
Value: clayic

QualifierValue
Value: colluvic
Value: cryic
Value: cryosolic
Value: cutanic
Value: densic
Value: drainic
Value: duric
Value: durisolic
Value: dystric
Value: ekranic
Value: endoduric
Value: endodystric
Value: endoeutric
Value: endofluvic
Value: endogleyic
Value: endoleptic
Value: endosalic

QualifierValue
Value: entic
Value: epidystric
Value: epieutric
Value: epileptic
Value: episalic
Value: escalic
Value: eutric
Value: eutrosilic
Value: ferralic
Value: ferralsolic
Value: ferric
Value: fibric
Value: floatic
Value: fluvic
Value: fluvisolic
Value: folic
Value: fractipetric
Value: fractiplinthic

QualifierValue
Value: fragic
Value: fulvic
Value: garbic
Value: gelic
Value: gelistagnic
Value: geric
Value: gibbsic
Value: glacic
Value: gleyic
Value: gleysolic
Value: glossalbic
Value: glossic
Value: greyic
Value: grumic
Value: gypsic
Value: gypsiric
Value: gypsisolic

QualifierValue
Value: haplic
Value: hemic
Value: histic
Value: histosolic
Value: hortic
Value: humic
Value: hydragric
Value: hydric
Value: hydrophobic
Value: hyperalbic
Value: hyperalic
Value: hypercalcic
Value: hyperdystric
Value: hypereutric
Value: hypergypsic
Value: hyperochric
Value: hypersalic
Value: hyperskeletic

QualifierValue
Value: hypocalcic
Value: hypogypsic
Value: hypoluvic
Value: hyposalic
Value: hyposodic
Value: irragric
Value: kastanozemic
Value: lamellic
Value: laxic
Value: leptic
Value: leptosolic
Value: lignic
Value: limnic
Value: linic
Value: lithic
Value: lixic
Value: lixisolic

QualifierValue
Value: luvic
Value: luvisolic
Value: magnesic
Value: manganiferric
Value: mazic
Value: melanic
Value: mesotrophic
Value: mollic
Value: molliglossic
Value: natric
Value: nitic
Value: nitisolic
Value: novic
Value: nudilithic
Value: ombric
Value: ornithic
Value: ortsteinic
Value: oxyaquic

QualifierValue
Value: pachic
Value: pellic
Value: petric
Value: petrocalcic
Value: petroduric
Value: petrogleyic
Value: petrogypsic
Value: petroplinthic
Value: petrosalic
Value: phaeozemic
Value: pisoplinthic
Value: placic
Value: plaggic
Value: planosolic
Value: plinthic
Value: plinthosolic
Value: podzolic

QualifierValue
Value: posic
Value: profondic
Value: protic
Value: puffic
Value: reductaquic
Value: reductic
Value: regic
Value: regosolic
Value: rendzic
Value: rheic
Value: rhodic
Value: rubic
Value: ruptic
Value: rustic
Value: salic
Value: sapric
Value: silandic
Value: siltic

QualifierValue
Value: skeletic
Value: sodic
Value: solodic
Value: solonchakic
Value: solonetzic
Value: sombric
Value: spodic
Value: spolic
Value: stagnic
Value: stagnosolic
Value: subaquatic
Value: sulphatic
Value: takyric
Value: technic
Value: technosolic
Value: tephric
Value: terric

QualifierValue
Value: thaptandic
Value: thaptovitric
Value: thionic
Value: thixotropic
Value: tidalic
Value: toxic
Value: transportic
Value: turbic
Value: umbric
Value: umbriglossic
Value: umbrisolic
Value: urbic
Value: vermic
Value: vertic
Value: vertisolic
Value: vetic
Value: vitric
Value: voronic

QualifierValue
Value: xanthic
Value: yermic

5.2.2.4.9. ReferenceSoilGroupValue

ReferenceSoilGroupValue	
Name:	WRB reference soil group (RSG)
Definition:	list of possible reference soil groups (i.e. first level of classification of the World Reference Base for Soil Resources).
Description:	*Reference Soil Groups* are distinguished by the presence (or absence) of specific *diagnostic horizons, properties* and/or *materials.* NOTE The WRB soil classification system comprises 32 different RSGs. SOURCE World reference base for soil resources 2006.
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May not be extended by Member States.
URI:	http://inspire-registry.jrc.ec.europa.eu/clr/ReferenceSoilGroupValue
Value: acrisol	
Value: albeluvisol	
Value: alisol	
Value: andosol	
Value: anthrosol	
Value: arenosol	
Value: calcisol	
Value: cambisol	
Value: chernozem	
Value: cryosol	
Value: durisol	

ReferenceSoilGroupValue
Value: ferralsol
Value: fluvisol
Value: gleysol
Value: gypsisol
Value: histosol
Value: kastanozem
Value: leptosol
Value: lixisol
Value: luvisol
Value: nitisol
Value: phaeozem
Value: planosol
Value: plinthosol
Value: podzol
Value: regosol
Value: solonchak
Value: solonetz

ReferenceSoilGroupValue
Value: stagnosol
Value: technosol
Value: umbrisol
Value: vertisol

5.2.2.4.10. SoilInvestigationPurposeValue

SoilInvestigationPurposeValue	
Name:	soil investigation purpose
Definition:	indicates why an observation is made within a survey.
Description:	Two main purposes are identified to carry out soil surveys. One is to classify the soil as a result of soil forming processes (soil characterization reconnaissance) and the other, to investigate possible contamination as a result of contaminating activities (soil contamination reconnaissance).
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May be extended by Member States.
URI:	http://inspire-registry.jrc.ec.europa.eu/clr/SoilInvestigationValue
Value: soilCharacterizationReconnaissance	
Name:	soil characterization reconnaissance
Definition:	soil characterisation with unbiased selection of investigation location.
Description:	EXAMPLE Soil characterisation for soil mapping, which involves identifying different soil types.
Value: soilContaminationReconnaissance	
Name:	soil contamination reconnaissance
Definition:	investigation of soil properties at locations biased by a specific purpose.
Description:	EXAMPLE investigation on potentially contaminated location

5.2.2.4.11. SoilPlotTypeValue

SoilPlotTypeValue	
Name:	soil plot type
Definition:	gives information on what kind of plot the observation of the soil is made.
Description:	NOTE Trial pits, boreholes or surfaces can be seen as types of soil plots.
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May not be extended by Member States.
URI:	http://inspire-registry.jrc.ec.europa.eu/clr/SoilPlotTypeValue
Value: borehole	
Name:	borehole
Definition:	penetration into the subsurface with removal of soil/rock material by using e. g. a hollow tube-shaped tool.

SoilPlotTypeValue	
Description:	NOTE 1 generally, it is a vertical penetration. NOTE 2 boring and bore are synonyms. SOURCE ISO 11074
Value: sampling	
Name:	sampling
Definition:	defined location of the earth's surface on which specific soil sampling is done.
Description:	EXAMPLE Location from the LUCAS survey SOURCE ISO/CD 25258
Value: surface	
Name:	surface
Definition:	defined area of the earth's surface on which an investigation or sampling is done.
Description:	EXAMPLE area of a plant association investigation, or area used for the extraction of anecic earthworm. SOURCE ISO/CD 25258
Value: trialPit	
Name:	trialpit
Definition:	excavation prepared to carry out profile descriptions, sampling, and/or field tests.
Description:	NOTE synonyms: test, pit trench, soil pit SOURCE ISO 11074

5.2.2.4.12. SpecifierValue

SpecifierValue	
Name:	WRB specifiers
Definition:	list of possible specifiers.
Description:	SOURCE World reference base for soil resources 2006.
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May not be extended by Member States.
URI:	http://inspire-registry.jrc.ec.europa.eu/clr/SpecifierValue
Value: bathy	
Value: cumuli	
Value: endo	
Value: epi	
Value: hyper	
Value: hypo	
Value: ortho	

SpecifierValue
Value: para
Value: proto
Value: thapto

5.2.2.5. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.2.2.5.1. Any

Any	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Implementation::Records and Class Metadata [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.5.2. CI_Citation

CI_Citation	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19115:2006 Metadata (Corrigendum)::Citation and responsible party information [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.5.3. CharacterString

CharacterString	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Text [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.5.4. DateTime

DateTime	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Date and Time [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.5.5. GFI_Feature

GFI_Feature (abstract)	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19156 Observations and Measurements::ISO FDIS 19156:2011 Observations and Measurements::General Feature Instance [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.5.6. GM_MultiSurface

GM_MultiSurface

GM_MultiSurface	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107:2003 Spatial Schema:: Geometry::Geometric aggregates [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.5.7. GM_Object

GM_Object (abstract)	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107:2003 Spatial Schema:: Geometry::Geometry root [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.5.8. GM_Surface

GM_Surface	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107:2003 Spatial Schema:: Geometry::Geometric primitive [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.5.9. Identifier

Identifier	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.2.2.5.10. Integer

Integer	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Numerics [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.5.11. Location

Location (abstract)	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19156 Observations and Measurements::ISO FDIS 19156:2011 Observations and Measurements::Sampling Features::specimen [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.5.12. Measure

Measure

Measure	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Derived::Units of Measure [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.5.13. Percentage

Percentage	
Package:	INSPIRE Consolidated UML Model::Themes::Annex I::Protected Sites::Protected Sites Simple [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A percentage value, being an integer between 0 and 100 inclusive.

Open issue 2: In the following sections an illustration is given of how the CORE model can be extended for specific purposes. This is done by the means of examples based on domain specific use cases. For each of these specific use cases it is illustrated how the core model application schema can be extended with additional objects and attributes that are needed to accommodate the specific requirements.

Due to time constraints it was not possible to include feature catalogues with the correct definitions.
Also these illustrated extensions are based on very specific Use Cases which are not generally applicable. For the version 3.0 of the data specifications we will look into the possibility to make more generic application schemas for those extensions and provide feature catalogues and encodings.

5.3 Extension of the Soil Core to implement the Use Case "*Agri-Environmental Indicator – Soil Erosion"*

5.3.1 Description

5.3.1.1. Narrative description

The UML Diagram "Soil-Use Case: Erosion" extends the Soil Core Model to implement the Use Case 1: "Agri-Environmental Indicator – Soil Erosion" (see Annex-B of this document). This Use Case requires a number of input base datasets, both soil-related and non-soil data, in order to produce a spatial data that represent the physical phenomenon 'soil erosion'. The required non-soil data are climatic data (rainfall and temperature), geomorphology data (slope, slope length) and land-cover data. The required soil data are: soil texture and possibly also soil structure and permeability, organic matter content.

The Soil-Core cares for the soil texture and organic matter content through the attributes *organicCarbonContent* (in ChemicalParametersType) and *particleSizeFracton* (in PhysicalParametersType) and needs extension for soil structure and permeability. Therefore, the PhysicalParametersType is extended with attributes that express structure (*primaryStructure*, *secondaryStructure*, *structureRelationship*) (according to Guidelines for soil description (4th ed.) FAO 2006) and permeability. Both *primaryStructure* and *secondaryStructure* are of a new data type *StructureType* that holds the *grade*, *size* and *structureType* attributes. *Grade* and *structureType* take values respectively from the new codelists *GradeValue* and *structureTypeValue*, while *size* is of the type *RangeType*, two values of the *Measure* type. These soil parameters resort under chemical and physical parameters, which in turn are associated to profile elements (horizons and layers) of soil profiles; therefore these soil parameters are associated to observed and derived profiles and soil complexes. Since the *sampledProperty* attribute of the *SoilSample* object is of type *Any*, these soil parameters can also be associated to soil samples.

The required non-soil data are introduced through the UML Dependencies for Atmospheric Conditions, Elevation and LandCover, which are elements (e.g. package or application scheme) that are external to the soil model. A dependency indicates that a model element in the consumer package (soil) is dependent on model element(s) in the supplier package.

The spatial data that represent the 'soil erosion' are modeled through the *SoilThematicObject*, which is defined in the core as a spatial object representing a soil related property derived from one or more soil properties. It represents values that are derived from data coming from one or more soil complexes, one or more observed soil profiles and/or one or more soil samples, which are all geo-referenced. A set of soil thematic objects are then used to derive a soil thematic map. The *soilThematicResult* attribute holds a value (of type *Any*) valid for the object *GM_Object* of the *geometry* attribute.

For the case of soil erosion, the value in *soilThematicResult* could represent soil erosion expressed in mass per area per year, for the geographical location indicated by GM_Object (a point or a polygon).

This value is to be computed from values of associated geo-referenced objects within the soil model (soil samples, soil complexes, observed profiles) and external to the soil model.

5.3.1.2. UML Overview

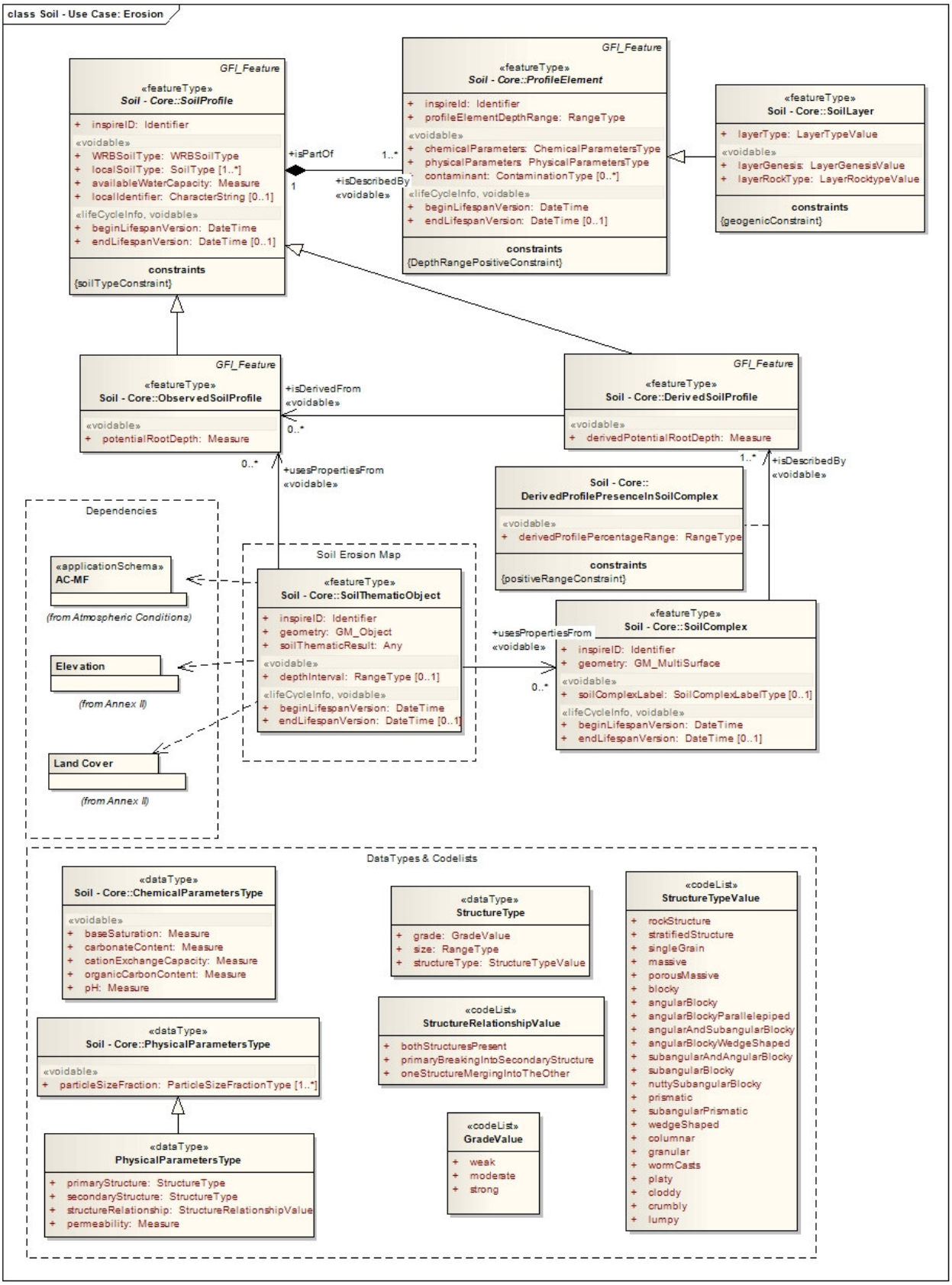


Figure 5 – UML class diagram: SOIL *Agri-Environmental Indicator – Soil Erosion extension*

5.4 Extension of the Soil Core to implement the Use Case "*Establishment Less Favoured Areas (France)*"

5.4.1 Description

5.4.1.1. Narrative description

The UML Diagram "Soil-Use Case: Less Favoured Areas" extends the Soil Core Model to implement the Use Case 10: "Test of biophysical criteria for determining Less Favoured Areas in France" (see Annex-B of this document). This Use Case describes how France tested the soil criteria proposed by the European Commission for its foreseen revision of Less Favoured Areas (LFA) zoning, using available soil datasets on test areas. The European Commission proposed the following criteria: drainage, texture and stoniness (stoniness, organic soils, heavy clay soils, sandy soils, vertic soils), rooting depth, chemical properties (salinity, sodicity, gypsum content) to evaluate soil handicap. They must be available on the total agricultural area.

The different criteria must be first evaluated at the *DerivedSoilProfile* level. The drainage criterion can be evaluated using the *DrainageClass* of the *DerivedSoilProfile*. Texture and stoniness correspond to several sub-criteria. Their evaluation needs to use the *ProfileElement* description of the *DerivedSoilProfile*, especially the *ProfileElementDepthRange* to know which horizons are present, their depth and thickness. Different characteristics of these horizons are also needed and can be found in the Soil Core model or extended using the *ChemicalParametersType* or the *PhysicalParametersType*.

Within the *ChemicalParametersType*, can be found:
- *organicCarbonContent* (for the organic soils criterion),
- *exchangeableSodium* (for sodicity criterion)
- *gypsumContent* (for gypsum criterion)

Within the *PhysicalParametersType*, can be found:
- *particleSizeFraction* (for heavy clay, sandy and vertic soils criteria).
- *electricalConductivity* (for salinity criterion)
- *coarseFragment* and *coarseFragmentDominantSize* (for stoniness criteria).

To be able to characterize the vertic soil criterion, the *FAOHorizonNotation* or the *LocalHorizonNotation* is required and also the *WRBSoilType* or the *localSoilType*.
The rooting depth criterion can be evaluated using the *derivedPotentialRootDepth* of the *DerivedSoilProfile*.

Finally, to calculate the percentage of area of the administrative unit covered by soils having handicaps for agriculture, it is necessary to use the *SoilComplex* geometry and the *derivedProfilePercentageRange* of each *DerivedSoilProfile* belonging to the *SoilComplex*.

5.4.1.2. UML Overview

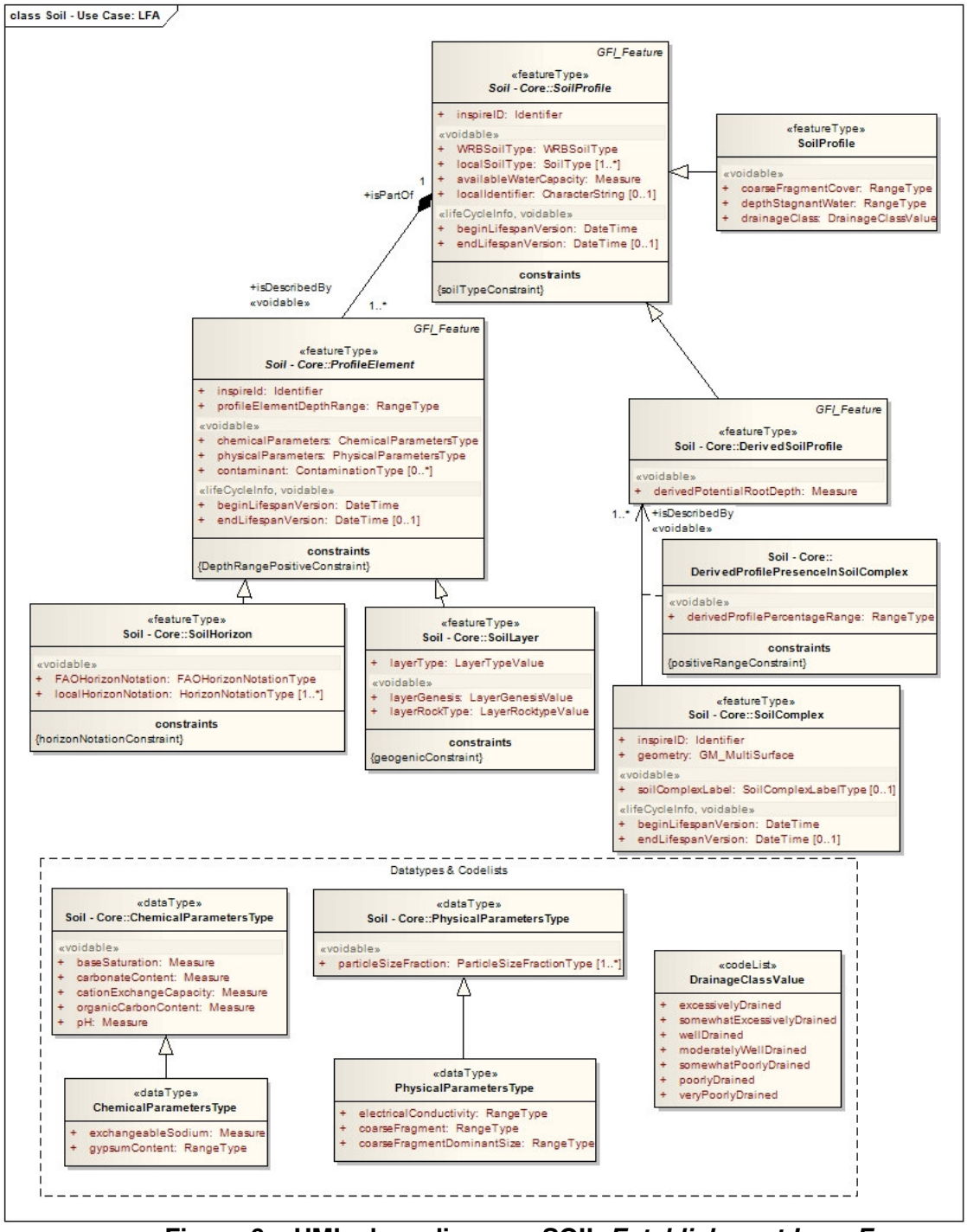


Figure 6 – UML class diagram: SOIL *Establishment Less Favoured Areas (France)*

5.5 Extension of the Soil Core to implement the Use Case "*Contamination in relation to property*"

5.5.1 Description

5.5.1.1. Narrative description

The contamination of the soil is a property of the soil that is of interest for the users and owners because it influences the applicability of the land / soil, due to the possible risk imposed by the contamination. The general cause is an external *ContaminatingActivity* (natural risk inducing levels are also conceivable, i.e. of arsenic). The extent of dispersion of the pollution defines the *SoilSite*, which is defined by information gathered in a *SoilPlot*.

The level of interest for owners and organisational basis for management is usually the *CadastralParcel* (A *SoilSite* may include several *CadastralParcels* or be part of a *CadastralParcel*). The *ContaminationActivity* is usually the starting point for initiatives and legal and financial regulations for contamination management. Involved (other) stakeholders may be users or potential new users, owners/investors on the SoilSite or similar stakeholders on neighbouring *CadastralParcels* which may be at risk because of possible dispersion across borders of the *CadastralParcels*.

Influence and further dispersion rates of the contamination are related to the type of contamination (*contaminantName*) and the concentration level (*measuredValue*), the mobility and bioavailability of the contamination (also related to it's age) and the distribution of the contamination over the *SoilLayers* (and it's future prospects). The distribution of the contamination determines the contact possibilities with users, direct and by media like crops and groundwater for drinking water (and runoff from a *SoilSite* to surface waters).

A decision on the need of management of the contamination should be based on soil investigations and/or evaluation of effects and exposure routes. The *LegalBaseValues* define legally the kind of action to be taken (and the period of starting the action) and may be on different (concentration) levels for each EU member state as well as for different land uses, sizes of contaminated areas and soil types. A tiered investigation procedure is common, starting with an *exploratorySurvey*, and if contamination appears to be on an alerting level going into more detailed *closerInvestigation*, continuing – if necessary - into investigations to get the information needed for *management/remediation*. After the implementation of the *remediationPlan* (or managementPlan) a *remediationEvaluation* may give a decisive answer on the need of further management.

To implement this Use Case, the Soil Core Model would need to be extended with additional objects and attributes.

The *SoilSite* class needs extension with the attributes *soilLegalBase* and *groundWaterLegalBase*, which take values from a new code-list *LegalBaseValue*. (As explained different sites may have different applicable *LegalBases*).

Since the purpose of investigation of the site can be more detailed than just *soilContaminationReconnaissance*, the *SoilInvestigationPurposeValue* code-list is extended with five new values.

Actual measurements of the soil are placed in the contaminant attribute of layers (probably of *layerType* "depthInterval"). For the uses-case the *ContaminantNameValue* code-list is expanded.

Soil layers (in which contaminant measurements are made) are not standalone objects and must be part of exactly one *ObservedSoilProfile*, which in turn must belong to exactly one *SoilPlot*. This *SoilPlot* is located on a *SoilSite*, that indicates the purpose for the soil investigation.

The new concept “cadastral parcel” is implemented through the new *CadastralParcel* object with a number of attributes that characterize it. The *SoilSite* on which the observations are made could (partially) cover zero or more *CadastralParcel’s* and thus vice versa a *CadastralParcel* could (partially) be covered by zero or more *SoilSite’s*.

The concept contaminating activity is modeled with the object *ContaminatingActivity*, with an attribute that indicates the status of the activity, and is linked to a parcel with the associations “is(historically)PresentOnParcel” and “is(historically)PresentWithin25mOfParcel”. (Remark: The distance of 25 m is strictly related to the described use case and may be chosen different in other situations.)

5.5.1.2. UML Overview

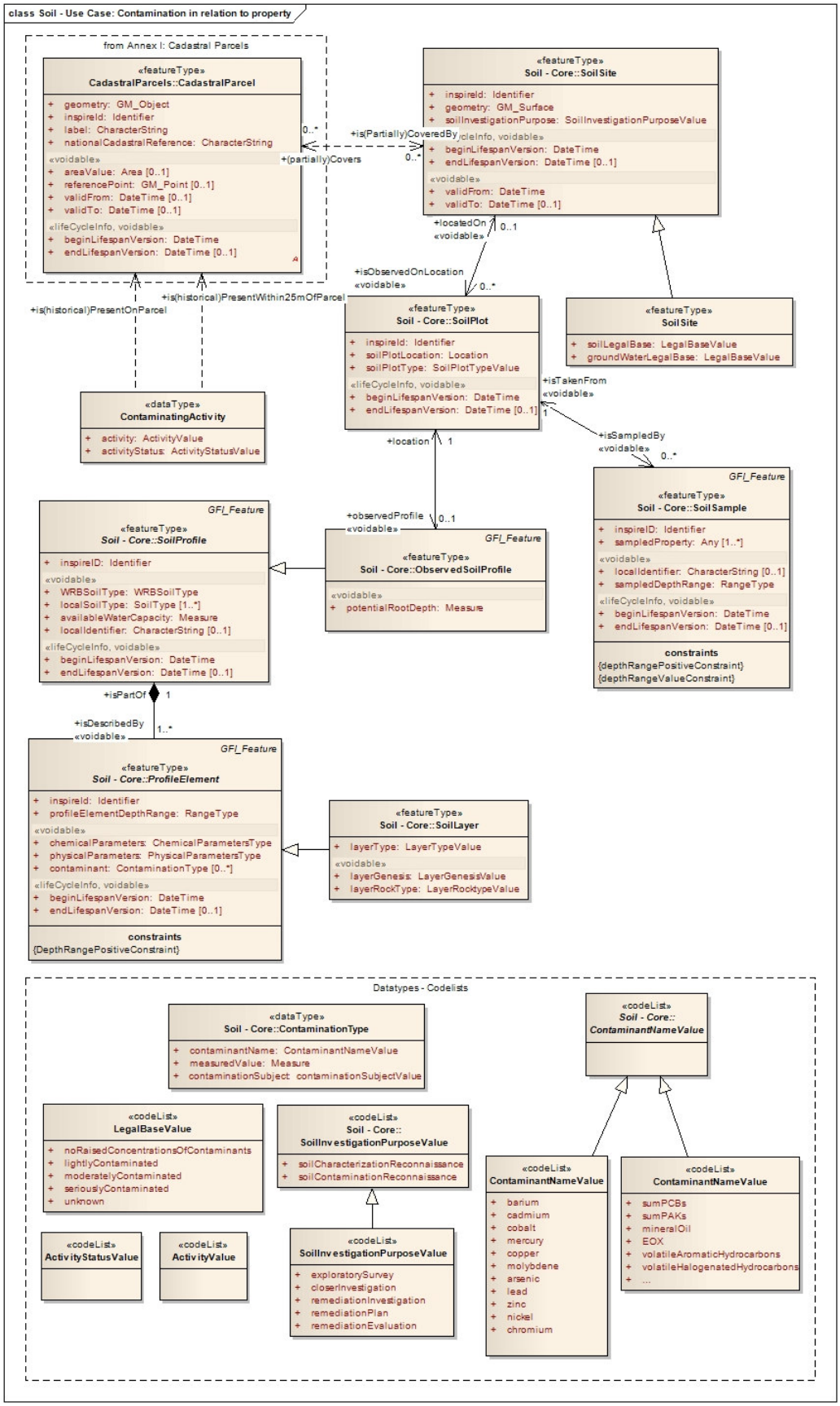


Figure 7 – UML class diagram: SOIL *Contamination in relation to property*

5.6 Extension of the Soil Core to implement the Use Case "*State of soil in Europe"*

5.6.1 Description

5.6.1.1. Narrative description

The UML Diagram "Soil-Use Case: Soil State" extends the Soil Core Model to implement the Use Case: "State of Soils in Europe" (see Annex-B of this document). This Use Case is designed in a general way in order to match the different approaches of the MS. The Use Case requires a number of input base datasets, both soil-related and non-soil data, in order to produce a spatial data that represent the state and the development of soil properties at a specific soil site. The non-soil data are climatic data (e.g. rainfall), land cover data (e.g. vegetation) and land use data (e.g. crop land) and the soil site covering a soil profile with associated soil samples. The required soil data are: the soil profile description and in addition a number of assigned circular measurements.
The Soil-Core cares for the most of the objects and the associated attributes.
The object *SoilSite* can be extended with the attributes *soilSiteType*, *landUse* and *vegetationType.* The *SoilSite* is linked with the object *SoilPlot* with attributes (*soilPlotLocation*, *soilPlotType*). *SoilPlot* is linked with the objects *ObservedSoilProfile* and *SoilSample* as core elements.
The object *ObservedSoilProfile*, as subtype of *SoilProfile, inherits the attributes WRBsoilType* and (alternatively) *localSoilType.* The *SoilProfile* is described by zero or more horizons and/or layers (subtypes of the abstract class *ProfileElement); each horizon and/or layer is characterized by a range of depths (attribute profileElementDepthRange)* and a number of observed *chemical* and *physical parameters* (e.g. *organicCarbonContent*, *ParticleSizeFraction*) as well as contaminants (e.g. *lead*); soil horizons and soil layers have additionally specific attributes: *FAOHorizonNotation and localHorizonNotation* for the *SolHorizion* object; *layerType, layerGenesis and layerRockType* for the SoilLayer object. The profile element can also be extended with *biologicalParameters* if necessary.
The *SoilSample* provides a *sampledProperty* which could be of *Any.*
Both the *SoilProfileElement* and the *SoilSample* object are linked to the core of the *OM* (*observation and measurements*) object which provides information about the data quality of measurements (*phenomenon time, resultQuality* and *parameter*); the OM object has not been fully defined yet.

The required non-soil data are introduced through the UML Dependencies for Atmospheric Conditions, Land Use and Land Cover, which are elements (e.g. package or application scheme) that are external to the soil model. A dependency indicates that a model element in the consumer package (soil) is dependent on model element(s) in the supplier package.

Soil state and soil development are spatially represented by the core *SoilPlot* object through a geographical point and/or the name of a location, but it are the attributes of associated soil samples and soil profiles that carry the soil state and development information. A set of *SoilPlot* Objects (and its associated samples and profiles) could constitute a (nationwide) soil database which is represented by this extended model.

5.6.1.2. UML Overview

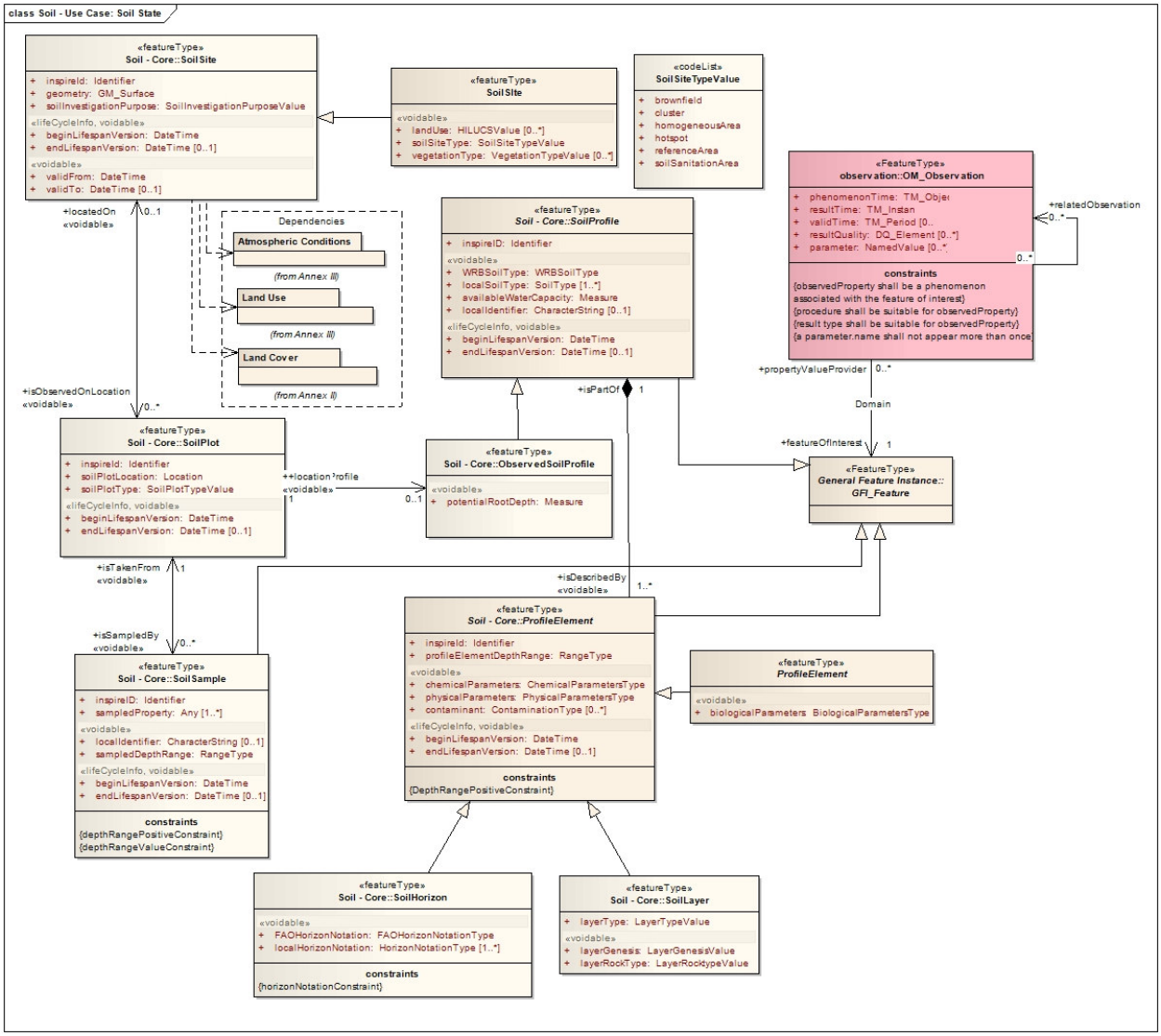


Figure 8 – UML class diagram: SOIL *State of soil in Europe*

6 Reference systems

6.1 Coordinate reference systems

6.1.1 Datum

IR Requirement 4 For the coordinate reference systems used for making available the INSPIRE spatial data sets, the datum shall be the datum of the European Terrestrial Reference System 1989 (ETRS89) in areas within its geographical scope, and the datum of the International Terrestrial Reference System (ITRS) or other geodetic coordinate reference systems compliant with ITRS in areas that are outside the geographical scope of ETRS89. Compliant with the ITRS means that the system definition is based on the definition of the ITRS and there is a well

established and described relationship between both systems, according to EN ISO 19111.

6.1.2 Coordinate reference systems

IR Requirement 5 INSPIRE spatial data sets shall be made available using one of the three-dimensional, two-dimensional or compound coordinate reference systems specified in the list below.

Other coordinate reference systems than those listed below may only be used for regions outside of continental Europe. The geodetic codes and parameters for these coordinate reference systems shall be documented, and an identifier shall be created, according to EN ISO 19111 and ISO 19127.

1. Three-dimensional Coordinate Reference Systems
   - Three-dimensional Cartesian coordinates
   - Three-dimensional geodetic coordinates (latitude, longitude and ellipsoidal height), using the parameters of the GRS80 ellipsoid

2. Two-dimensional Coordinate Reference Systems
   - Two-dimensional geodetic coordinates, using the parameters of the GRS80 ellipsoid
   - Plane coordinates using the Lambert Azimuthal Equal Area projection and the parameters of the GRS80 ellipsoid
   - Plane coordinates using the Lambert Conformal Conic projection and the parameters of the GRS80 ellipsoid
   - Plane coordinates using the Transverse Mercator projection and the parameters of the GRS80 ellipsoid

3. Compound Coordinate Reference Systems
   - For the horizontal component of the compound coordinate reference system, one of the two-dimensional coordinate reference systems specified above shall be used
   - For the vertical component on land, the European Vertical Reference System (EVRS) shall be used to express gravity-related heights within its geographical scope
   - Other vertical reference systems related to the Earth gravity field shall be used to express gravity-related heights in areas that are outside the geographical scope of EVRS. The geodetic codes and parameters for these vertical reference systems shall be documented and an identifier shall be created, according to EN ISO 19111 and ISO 19127
   - For the vertical component measuring the depth of the sea floor, where there is an appreciable tidal range, the Lowest Astronomical Tide shall be used as reference surface. In marine areas without an appreciable tidal range, in open oceans and effectively in waters that are deeper than 200 m, the depth of the sea floor shall be referenced to the Mean Sea Level
   - For the vertical component measuring depths above the sea floor in the free ocean, barometric pressure shall be used
   - For the vertical component in the free atmosphere, barometric pressure, converted to height using ISO 2533:1975 International Standard Atmosphere shall be used

6.1.3 Display

IR Requirement 6 For the display of the INSPIRE spatial data sets with the View Service specified in D003152/02 Draft Commission Regulation implementing Directive 2007/2/EC of the European Parliament and of the Council as regards Network Services, at least the two dimensional geodetic coordinate system shall be made available.

6.1.4 Identifiers for coordinate reference systems

IR Requirement 7 For referring to the non-compound coordinate reference systems listed in this Section, the identifiers listed below shall be used.

For referring to a compound coordinate reference system, an identifier composed of the identifier of the horizontal component, followed by a slash (/), followed by the identifier of the vertical component, shall be used.

- ETRS89-XYZ for Cartesian coordinates in ETRS89
- ETRS89-GRS80h for three-dimensional geodetic coordinates in ETRS89 on the GRS80 ellipsoid
- ETRS89-GRS80 for two-dimensional geodetic coordinates in ETRS89 on the GRS80
- EVRS for height in EVRS
- LAT for depth of the sea floor, where there is an appreciable tidal range
- MSL for depth of the sea floor, in marine areas without an appreciable tidal range, in open oceans and effectively in waters that are deeper than 200m
- ISA for pressure coordinate in the free atmosphere
- PFO for Pressure coordinate in the free ocean
- ETRS89-LAEA for ETRS89 coordinates projected into plane coordinates by the Lambert Azimuthal Equal Area projection
- ETRS89-LCC for ETRS89 coordinates projected into plane coordinates by the Lambert Conformal Conic projection
- ETRS89-TMzn for ETRS89 coordinates projected into plane coordinates by the Transverse Mercator projection

6.2 Temporal reference system

IR Requirement 8 The Gregorian Calendar shall be used for as a reference system for date values, and the Universal Time Coordinated (UTC) or the local time including the time zone as an offset from UTC shall be used as a reference system for time values.

6.3 Theme-specific requirements and recommendations on reference systems

There are no theme-specific requirements or recommendations on reference systems.

7 Data quality

This chapter includes a description of data quality elements and sub-elements as well as the associated data quality measures (section 7.1). The selected data quality measures should be used to

evaluate quality of data sets for a specific data quality element / sub-element. The evaluation can be performed at the level of spatial object, spatial object type, dataset or dataset series.

The results of the evaluation are then reported at the spatial object type or dataset level in metadata utilising the same data quality elements and measures (see chapter 8).

NOTE The selection of appropriate data quality measures represents the first step towards the harmonisation of documenting data quality.

In addition, for some of the data quality elements described in section 7.1, minimum data quality requirements or recommendations may be defined. These are described in the section 1.2.

Recommendation 1 If data quality information is required at spatial object level then it should be modelled in the data model as an attribute of a relevant spatial object type.

7.1 Data quality elements and measures

Recommendation 2 To evaluate and report the data quality of data sets related to the spatial data theme **SOIL**, the elements and measures listed in Table 2 should be used.

Table 2 – Data quality elements for evaluating and reporting the data quality of data sets related to the spatial data theme SOIL

Section	Data quality element and sub-element
7.1.1	Completeness – Commission
7.1.2	Completeness – Omission
7.1.3	Logical Consistency – Topological consistency
7.1.4	Logical Consistency – Domain consistency

7.1.1 Completeness – Commission

Commission should be documented using the rate of excess items.

Name	Rate of excess items
Alternative name	–
Data quality element	Completeness
Data quality sub-element	Commission
Data quality basic measure	Error rate
Definition	Number of excess items in the dataset in relation to the number of items that should have been present.
Description	Derived profiles are based on observed profiles. In practice the number of used observed profiles can vary for each derived profile and can even be zero. This depends on expert judgement on one hand and available observed profiles on the other hand. This quality measure is not necessarily an error but it is an indication on the quality of the derived profiles.
Evaluation scope	spatial object type: DerivedSoilProfile evaluation is made based on the association “isDerivedFrom”

	between observedSoilProfile and DerivedSoilProfile, where the number of used observedProfiles quantifies to a certain extent the quality
Reporting scope	spatial object type: DerivedSoilProfile reporting is based on the association "isDerivedFrom" between observedSoilProfile and DerivedSoilProfile, where the average number of used observedProfiles is a measure for the whole data set and/or on a instance level the number of profiles used for each type is a measure for the DerivedProfile.
Parameter	–
Data quality value type	Real, percentage, ratio (example: 0,0189 ; 98,11% ; 11:582)
Data quality value structure	–
Source reference	–
Example	Three ObservedProfiles are used to generate DerivedSoilProfile.
Measure identifier	3 (ISO 19138)

7.1.2 Completeness – Omission

Omission should be documented using the rate of missing items.

Name	**Rate of missing items**
Alternative name	–
Data quality element	Completeness
Data quality sub-element	Omission
Data quality basic measure	Error rate
Definition	Number of missing items in the dataset in relation to the number of items that should have been present.
Description	In a dataset profiles, profile element and/or complexes can be missing due to the fact they do not appear in the extent of area under consideration. This is not necessarily a data set with a poorer Data Quality, but this is more difficult to compare with areas where these features are present.
Evaluation scope	spatial object type: SoilProfile, ProfileElement, SoilComplex in data sets and/or data set series. Evaluation will result in different possibilities: Completely missing in the data series (a real omission), missing in data series but not present in the data set, where in combination with topology constraint can be identified there is a real omission in the data set.
Reporting scope	spatial object type: SoilProfile, ProfileElement, SoilComplex in data sets and/or data set series. Evaluation will result in different possibilities: Reporting will result in omitted or missing but not omitted.
Parameter	–
Data quality value type	Real, percentage, ratio (example: 0,0189 ; 98,11% ; 11:582)
Data quality value structure	–
Source reference	–
Example	A derived profile A is present in area X and not present in Area Y. Which means that the dataset of area B does not have to contain profile type A
Measure identifier	7 (ISO 19138)

7.1.3 Logical Consistency – Topological consistency

Topological consistency should be documented using conceptual schema noncompliance and number of invalid overlaps of surfaces

Name	number of invalid overlaps of surfaces
Alternative name	overlapping surfaces
Data quality element	Logical consistency
Data quality sub-element	Topological consistency
Data quality basic measure	Error count
Definition	Total number of overlaps within the data
Description	SoilComplexes and SoilThematic features when mapped should be non-overlapping for the described area. When reporting this data quality measure, the types of feature classes corresponding to the overlapping surfaces shall be reported as well.
Parameter	-
Data quality value type	Integer
Data quality value structure	-
Source reference	-
Example	To be added
Measure identifier	11 (ISO 19138)

7.1.4 Logical Consistency – Domain consistency

domain consistency should be documented using number of items not in conformance with their value domain.

Name	number of items not in conformance with their value domain
Alternative name	-
Data quality element	logical consistency
Data quality sub-element	domain consistency
Data quality basic measure	Error count
Definition	Count of all items in the dataset that are not in conformance with their value domain
Description	When the physical parameter type is ParticleSizeFraction one of its properties is fractionContent expressed in percentages. All the fractionContents of the SizeRranges should add up to 100% to be correct.
Evaluation scope	spatial object: ParticleSizeFraction
Reporting scope	spatial object type: fractionContent
Parameter	
Data quality value type	Integer
Data quality value structure	
Source reference	
Example	To be added
Measure identifier	16 (ISO 19138)

Name	number of items not in conformance with their value domain
Alternative name	-
Data quality element	logical consistency

Data quality sub-element	domain consistency
Data quality basic measure	Error count
Definition	Count of all items in the dataset that are not in conformance with their value domain
Description	If within a SoilComplex the derivedProfilePercentageRanges are single values (upper and lower are equal or only one value is given) the sum of the percentages of all present derived profiles must add up to 100%. If ranges are given the sum cannot add up exactly to 100%. This means this data quality measure is only used for single values.
Evaluation scope	spatial object: SoilComplex
Reporting scope	spatial object type: derivedSoilProfilePercentageRange
Parameter	
Data quality value type	Integer
Data quality value structure	
Source reference	
Example	To be added
Measure identifier	16 (ISO 19138)

7.2 Minimum data quality requirements and recommendations

No minimum data quality requirements are defined.

8 Dataset-level metadata

Metadata can be reported for each individual spatial object (spatial object-level metadata) or once for a complete dataset or dataset series (dataset-level metadata). Spatial object-level metadata is fully described in the application schema (section **5**). If data quality elements are used at spatial object level, the documentation shall refer to the appropriate definition in section 7. This section only specifies dataset-level metadata elements.

For some dataset-level metadata elements, in particular on data quality and maintenance, a more specific scope can be specified. This allows the definition of metadata at sub-dataset level, e.g. separately for each spatial object type. When using ISO 19115/19139 to encode the metadata, the following rules should be followed:

- The scope element (of type DQ_Scope) of the DQ_DataQuality subtype should be used to encode the scope.
- Only the following values should be used for the level element of DQ_Scope: Series, Dataset, featureType.
- If the level is featureType the levelDescription/MDScopeDescription/features element (of type Set< GF_FeatureType>) shall be used to list the feature type names.

NOTEThe value featureType is used to denote spatial object type.

Mandatory or conditional metadata elements are specified in Section 8.1. Optional metadata elements are specified in Section 8. The tables describing the metadata elements contain the following information:

- The first column provides a reference to a more detailed description.
- The second column specifies the name of the metadata element.
- The third column specifies the multiplicity.
- The fourth column specifies the condition, under which the given element becomes mandatory (only for Table 3 and Table 4).

8.1 Common metadata elements

IR Requirement 9	The metadata describing a spatial data set or a spatial data set series related to the theme **SOIL** shall comprise the metadata elements required by Regulation 1205/2008/EC (implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata) for spatial datasets and spatial dataset series (Table 3) as well as the metadata elements specified in Table 4.

Table 3 – Metadata for spatial datasets and spatial dataset series specified in Regulation 1205/2008/EC (implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata)

Metadata Regulation Section	Metadata element	Multiplicity	Condition
1.1	Resource title	1	
1.2	Resource abstract	1	
1.3	Resource type	1	
1.4	Resource locator	0..*	Mandatory if a URL is available to obtain more information on the resource, and/or access related services.
1.5	Unique resource identifier	1..*	
1.7	Resource language	0..*	Mandatory if the resource includes textual information.
2.1	Topic category	1..*	
3	Keyword	1..*	
4.1	Geographic bounding box	1..*	
5	Temporal reference	1..*	
6.1	Lineage	1	
6.2	Spatial resolution	0..*	Mandatory for data sets and data set series if an equivalent scale or a resolution distance can be specified.
7	Conformity	1..*	
8.1	Conditions for access and use	1..*	

8.2	Limitations on public access	1..*	
9	Responsible organisation	1..*	
10.1	Metadata point of contact	1..*	
10.2	Metadata date	1	
10.3	Metadata language	1	

Table 4 – Mandatory and conditional common metadata elements

INSPIRE Data Specification SOIL **Section**	**Metadata element**	**Multiplicity**	**Condition**
8.1.1	Coordinate Reference System	1	
8.1.2	Temporal Reference System	0..*	Mandatory, if the spatial data set or one of its feature types contains temporal information that does not refer to the Gregorian Calendar or the Coordinated Universal Time.
8.1.3	Encoding	1..*	
8.1.4	Character Encoding	0..*	Mandatory, if an encoding is used that is not based on UTF-8.
8.1.5	Data Quality – Logical Consistency – Topological Consistency	0..*	Mandatory, if the data set includes types from the Generic Network Model and does not assure centreline topology (connectivity of centrelines) for the network.

8.1.1 Coordinate Reference System

Metadata element name	**Coordinate Reference System**
Definition	Description of the coordinate reference system used in the dataset.
ISO 19115 number and name	13. referenceSystemInfo
ISO/TS 19139 path	referenceSystemInfo
INSPIRE obligation / condition	mandatory
INSPIRE multiplicity	1
Data type(and ISO 19115 no.)	189. MD_CRS
Domain	Either the referenceSystemIdentifier (RS_Identifier) or the projection (RS_Identifier), ellipsoid (RS_Identifier) and datum (RS_Identifier) properties shall be provided. NOTE More specific instructions, in particular on pre-defined values for filling the referenceSystemIdentifier attribute should be agreed among Member States during the implementation phase to support interoperability.
Implementing instructions	
Example	referenceSystemIdentifier: code: ETRS_89 codeSpace: INSPIRE RS registry

Example XML encoding	<gmd:referenceSystemInfo> <gmd:MD_ReferenceSystem> <gmd:referenceSystemIdentifier> <gmd:RS_Identifier> <gmd:code> <gco:CharacterString>ETRS89 </gco:CharacterString> </gmd:code> <gmd:codeSpace> <gco:CharacterString>INSPIRE RS registry</gco:CharacterString> </gmd:codeSpace> </gmd:RS_Identifier> </gmd:referenceSystemIdentifier> </gmd:MD_ReferenceSystem> </gmd:referenceSystemInfo>
Comments	

8.1.2 Temporal Reference System

Metadata element name	**Temporal Reference System**
Definition	Description of the temporal reference systems used in the dataset.
ISO 19115 number and name	13. referenceSystemInfo
ISO/TS 19139 path	referenceSystemInfo
INSPIRE obligation / condition	Mandatory, if the spatial data set or one of its feature types contains temporal information that does not refer to the Gregorian Calendar or the Coordinated Universal Time.
INSPIRE multiplicity	0..*
Data type(and ISO 19115 no.)	186. MD_ReferenceSystem
Domain	No specific type is defined in ISO 19115 for temporal reference systems. Thus, the generic MD_ReferenceSystem element and its reference SystemIdentifier (RS_Identifier) property shall be provided. NOTEMore specific instructions, in particular on pre-defined values for filling the referenceSystemIdentifier attribute should be agreed among Member States during the implementation phase to support interoperability.
Implementing instructions	
Example	referenceSystemIdentifier: code: GregorianCalendar codeSpace: INSPIRE RS registry

Example XML encoding	<gmd:referenceSystemInfo> <gmd:MD_ReferenceSystem> <gmd:referenceSystemIdentifier> <gmd:RS_Identifier> <gmd:code> <gco:CharacterString>GregorianCalendar</gco:CharacterString> </gmd:code> <gmd:codeSpace> <gco:CharacterString>INSPIRE RS registry</gco:CharacterString> </gmd:codeSpace> </gmd:RS_Identifier> </gmd:referenceSystemIdentifier> </gmd:MD_ReferenceSystem> </gmd:referenceSystemInfo>
Comments	

8.1.3 Encoding

Metadata element name	**Encoding**
Definition	Description of the computer language construct that specifies the representation of data objects in a record, file, message, storage device or transmission channel
ISO 19115 number and name	271. distributionFormat
ISO/TS 19139 path	distributionInfo/MD_Distribution/distributionFormat
INSPIRE obligation / condition	mandatory
INSPIRE multiplicity	1
Data type (and ISO 19115 no.)	284. MD_Format
Domain	See B.2.10.4. The property values (name, version, specification) specified in section 9 shall be used to document the default and alternative encodings.
Implementing instructions	
Example	name: **SOIL** GML application schema version: version **2.0**, GML, version 3.2.1 specification: D2.8.**III.3** Data Specification on **SOIL** – Draft Guidelines
Example XML encoding	<gmd:MD_Format> <gmd:name> <gco:CharacterString> **SOIL** GML application schema </gco:CharacterString> </gmd:name> <gmd:version> <gco:CharacterString>**2.0**, GML, version 3.2.1</gco:CharacterString> </gmd:version> <gmd:specification> <gco:CharacterString>D2.8.**III.3** Data Specification on **SOIL** – Draft Guidelines</gco:CharacterString> </gmd:specification> </gmd:MD_Format>
Comments	

8.1.4 Character Encoding

Metadata element name	**Character Encoding**
Definition	The character encoding used in the data set.
ISO 19115 number and name	
ISO/TS 19139 path	
INSPIRE obligation / condition	Mandatory, if an encoding is used that is not based on UTF-8.
INSPIRE multiplicity	0..*
Data type (and ISO 19115 no.)	
Domain	
Implementing instructions	
Example	-
Example XML encoding	<gmd:characterSet> <gmd:MD_CharacterSetCode codeListValue="8859part2" codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/resources/Codelist/ML_gmxCodelists.xml#CharacterSetCode">8859-2</gmd:MD_CharacterSetCode> </gmd:characterSet>
Comments	

8.1.5 Data Quality – Logical Consistency – Topological Consistency

Metadata element name	**Data Quality – Logical Consistency – Topological Consistency**
Definition	Correctness of the explicitly encoded topological characteristics of the dataset as described by the scope
ISO 19115 number and name	18. dataQualityInfo
ISO/TS 19139 path	dataQualityInfo
INSPIRE obligation / condition	Mandatory, if the data set includes types from the Generic Network Model and does not assure centreline topology (connectivity of centrelines) for the network.
INSPIRE multiplicity	0..*
Data type (and ISO 19115 no.)	115. DQ_TopologicalConsistency
Domain	Lines 100-107 from ISO 19115
Implementing instructions	This metadata should be filled, at least, with these elements: - valueUnit: UnitOfMeasure - value: Record
Example	
Example XML encoding	
Comments	See clauses on topological consistency in section 7 for detailed information. This metadata element is mandatory if connectivity is not assured for network centrelines in the dataset. In this case the *Connectivity tolerance* parameter – as described in section 7 – must be provided in order to ensure automatic and unambiguous creation of centreline topology in post-process.

8.2 Metadata elements for reporting data quality

Recommendation 3 For reporting the results of the data quality evaluation quantitatively, the data quality elements and measures defined in chapter 7 should be used.

The scope for reporting may be different from the scope for evaluating data quality (see section 7). If data quality is reported at the data set or spatial object type level, the results are usually derived or aggregated.

Metadata element name	**See chapter 7**
Definition	See chapter 7
ISO 19115 number and name	80. report
ISO/TS 19139 path	dataQualityInfo/*/report
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..*
Data type (and ISO 19115 no.)	Corresponding DQ_xxx element from ISO 19115, e.g. 109. DQ_CompletenessCommission
Domain	Lines 100-107 from ISO 19115 100. nameOfMeasure : CharacterString [0..*] 101. measureIdentification : MD_Identifier [0..1] 102. measureDescription : CharacterString [0..1] 103. evaluationMethodType : DQ_EvaluationMethodTypeCode [0..1] 104. evaluationMethodDescription : CharacterString [0..1] 105. evaluationProcedure : CI_Citation [0..1] 106. dateTime : DateTime [0..*] 107. result : DQ_Result [1..2]
Implementing instructions	**Recommendation 4** For each DQ result included in the metadata, at least the following properties should be provided: 100. nameOfMeasure NOTE This should be the name as defined in Chapter 7. 103. evaluationMethodType 104. evaluationMethodDescription NOTE If the reported data quality results are derived or aggregated (i.e. the scope levels for evaluation and reporting are different), the derivation or aggregation should also be specified using this property. 106. dateTime NOTE This should be data or range of dates on which the data quality measure was applied. 107. result NOTE This should be of type DQ_QuantitativeResult
Example	
Example XML encoding	
Comments	See Chapter 7 for detailed information on the individual data quality elements and measures to be used.

Open issue 3: In the ongoing revision of ISO 19115 and development of new ISO 19157 standard (Geographic Information – Data quality), a new element is introduced (DQ_DescriptiveResult). This

element enables to describe and report qualitative results of the data quality evaluation and could be used instead of DQ_QuantitativeResult. Once the new (version of the) standards are approved, these guidelines will be revisited and be updated if necessary.

Open issue 4: For reporting compliance with minimum data quality requirements and recommendations specified in section 7, the INSPIRE conformity metadata element should be used.

However, since this issue is part of the larger discussion on the Abstract Test Suite and the definition of conformance classes for the data specification, detailed instructions on how to provide metadata on compliance with minimum data quality requirements and recommendations will only be provided for v3.0.

8.3 Theme-specific metadata elements

IR Requirement 10 The metadata describing a spatial data set or a spatial data set series related to the theme **SOIL** shall also comprise the theme-specific metadata elements specified in Table 5.

Table 5 – Mandatory and conditional theme-specific metadata elements for the theme SOIL

INSPIRE Data Specification SOIL **Section**	**Metadata element**	**Multiplicity**	**Condition**
8.3.1	Source	0..*	Mandatory, if a source can be specified
8.3.2	Omission	0..*	Mandatory
8.3.3	Domain consistency	0..*	Mandatory
8.3.4	Topological consistency	0..*	Mandatory

Recommendation 5 The metadata describing a spatial data set or a spatial data set series related to the theme **SOIL** should comprise the theme-specific metadata elements specified in Table 6.

Table 6 – Optional theme-specific metadata elements for the theme SOIL

INSPIRE Data Specification SOIL **Section**	**Metadata element**	**Multiplicity**
8.3.5	Maintenance Information	0..1

8.3.1 Source

Specify metadata elements using the template below. Include one section for each element.

Metadata element name	**Source**
Definition	Input data source of the described dataset/dataset series, e.g. a map from which the described dataset was derived.
ISO 19115 number and name	85. source
ISO/TS 19139 path	dataQualityInfo/*/lineage/*/source/*/sourceCitation/*/title
INSPIRE obligation / condition	Mandatory, if a source can be specified.
INSPIRE multiplicity	0..*
Data type (and ISO 19115 no.)	92. LI_Source

Domain	The following properties are expected:
	• description (Free text)
	• scaleDenominator, i.e. source mapping scale
	  ○ denominator (Integer)
	• sourceCitation
	  ○ title (Free text)
	  ○ date, i.e.source date of mapping
	  ▪ date (according to ISO 8601, see section **Error! Reference source not found.** for examples)
	  ▪ dateType (i.e. creation, revision or publication)
	Source description is mandatory. Source title and date of mapping are mandatory if it can be specified. Scale denominator is optional.

Implementing instructions *(optional)*	• Description shall contain an overall description of the source, even if the source is an analogue map and the resource is a 1 : 1 copy of the source. • Source title shall be the full name of the source dataset. If the title contains a scale, the scale must be expressed also in the scaleDenominator property. • Source date of mapping shall express a date, when the source was created, revised, and/or published, i.e. this is the date of the original source version which was used as input source for the described dataset. • It is possible to describe several dates for one source. However, the creation date must not be specified more than once. • In case of a source with known scale (e.g. 1 : 50 000), specify the scale denominator (scaleDenominator/denominator) as the number following after the colon (e.g. 50000). • Source scale must not be specified more than once.

Example *(optional)*	• description: **This vector dataset depicts the soil series boundary lines identified by the Soil Survey of Northern Ireland.**
	• scaleDenominator
	  ○ denominator: **50000**
	• sourceCitation
	  ○ title: **AFBI 50k Soil Map**
	  ○ date
	  ▪ date: **1997-01-01**
	  ▪ dateType: **publication**

Example XML encoding *(optional)*	<gmd:MD_Metadata .. .. <gmd:dataQualityInfo> .. <gmd:lineage> <gmd:LI_Lineage> <gmd:source> <gmd:LI_Source> <gmd: description> <gco:CharacterString>**This vector dataset depicts the soil series boundary lines identified by the Soil Survey of Northern Ireland.**</gco:CharacterString> </gmd:description> <gmd:scaleDenominator> <gmd:MD_RepresentativeFraction> <gmd:denominator> <gco:Integer>**50000**</gco:Integer> </gmd:denominator> </gmd:MD_RepresentativeFraction> </gmd:scaleDenominator> ..<gmd:sourceCitation> <gmd:CI_Citation> <gmd:title> <gco:CharacterString>**AFBI 50k Soil Map**</gco:CharacterString> </gmd:title> .. <gmd:date> <gmd:CI_Date> <gmd:date> <gco:Date>**1997-01-01**</gco:Date> </gmd:date> <gmd:dateType> <gmd:CI_DateTypeCode codeList="**http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/resources/Codelist/ML_gmxCodelists.xml#CI_DateTypeCode**" codeListValue="**publication**">**publication**</gmd:CI_DateTypeCode> </gmd:dateType> </gmd:CI_Date> </gmd:date> .. </gmd:CI_Citation> </gmd:sourceCitation> </gmd:LI_Source> </gmd:source> .. </gmd:LI_Lineage> </gmd:lineage> </gmd:dataQualityInfo> .. </gmd:MD_Metadata>
Comments *(optional)*	<comments>

8.3.2 Omission

Open issue 5: The reporting MD_Elements are partly specified, implementing instructions still have to be added.

Metadata element name	Omission
Definition	excess data present in the dataset, as described by the scope
ISO 19115 number and name	80. report
ISO/TS 19139 path	dataQualityInfo/*/report
INSPIRE obligation / condition	mandatory
INSPIRE multiplicity	0..*
Data type (and ISO 19115 no.)	109. DQ_CompletenessCommission
Domain	Lines 100-107 from ISO 19115 100. nameOfMeasure (O) 101. measureIdentification (O) 102. measureDescription (O) 103. evaluationMethodType (O) 104. evaluationMethodDescription (O) 105. evaluationProcedure (O) 106. dateTime (O) 107. result : DQ_Result (M)
Implementing instructions	100 should be the name as defined in 7 101 should be … 107 should be of type DQ_QuantitativeResult. Recommendation: For each DQ result included in the metadata, at least the following properties should be provided: 100, 103, 104, 107
Example	Add example
Example XML encoding	
Comments	See Chapter 7 for detailed information on the individual data quality elements and measures to be used.

8.3.3 Domain consistency

Metadata element name	Domain consistency
Definition	degree of adherence to logical rules of data structure, attribution and relationships (data structure can be conceptual, logical or physical)
ISO 19115 number and name	80. report
ISO/TS 19139 path	dataQualityInfo/*/report
INSPIRE obligation / condition	mandatory
INSPIRE multiplicity	0..*
Data type (and ISO 19115 no.)	111. DQ_LogicalConsistency

Domain	Lines 100-107 from ISO 19115 100. nameOfMeasure (O) 101. measureIdentification (O) 102. measureDescription (O) 103. evaluationMethodType (O) 104. evaluationMethodDescription (O) 105. evaluationProcedure (O) 106. dateTime (O) 107. result : DQ_Result (M)
Implementing instructions	100 should be the name as defined in 7 101 should be … 107 should be of type DQ_QuantitativeResult. Recommendation: For each DQ result included in the metadata, at least the following properties should be provided: 100, 103, 104, 107
Example	Add example
Example XML encoding	
Comments	See Chapter 7 for detailed information on the individual data quality elements and measures to be used.

8.3.4 Topological consistency

Metadata element name	**Topological consistency**
Definition	correctness of the explicitly encoded topological characteristics of the dataset as described by the scope
ISO 19115 number and name	80. report
ISO/TS 19139 path	dataQualityInfo/*/report
INSPIRE obligation / condition	mandatory
INSPIRE multiplicity	0..*
Data type (and ISO 19115 no.)	115. DQ_TopologicalConsistency
Domain	Lines 100-107 from ISO 19115 100. nameOfMeasure (O) 101. measureIdentification (O) 102. measureDescription (O) 103. evaluationMethodType (O) 104. evaluationMethodDescription (O) 105. evaluationProcedure (O) 106. dateTime (O) 107. result : DQ_Result (M)
Implementing instructions	100 should be the name as defined in 7 101 should be … 107 should be of type DQ_QuantitativeResult. Recommendation: For each DQ result included in the metadata, at least the following properties should be provided: 100, 103, 104, 107
Example	Add example
Example XML encoding	
Comments	See Chapter 7 for detailed information on the individual data quality elements and measures to be used.

8.3.5 Maintenance Information

Metadata element name	Maintenance information
Definition	Information about the scope and frequency of updating
ISO 19115 number and name	30. resourceMaintenance
ISO/TS 19139 path	identificationInfo/MD_Identification/resourceMaintenance
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..1
Data type(and ISO 19115 no.)	142. MD_MaintenanceInformation
Domain	This is a complex type (lines 143-148 from ISO 19115). At least the following elements should be used (the multiplicity according to ISO 19115 is shown in parentheses): – maintenanceAndUpdateFrequency [1]: frequency with which changes and additions are made to the resource after the initial resource is completed / domain value: MD_MaintenanceFrequencyCode: – updateScope [0..*]: scope of data to which maintenance is applied / domain value: MD_ScopeCode – maintenanceNote [0..*]: information regarding specific requirements for maintaining the resource / domain value: free text
Implementing instructions	
Example	
Example XML encoding	
Comments	

8.4 Guidelines on using metadata elements defined in Regulation 1205/2008/EC

8.4.1 Conformity

The *Conformity* metadata element defined in Regulation 1205/2008/EC allows to report the conformance with the Implementing Rule for interoperability of spatial data sets and services or another specification. The degree of conformity of the dataset can be *Conformant* (if the dataset is fully conformant with the cited specification), *Not Conformant* (if the dataset does not conform to the cited specification) or *Not evaluated* (if the conformance has not been evaluated).

Recommendation 6 The Conformity metadata element should be used to report conceptual consistency with this INSPIRE data specification. The value of Conformant should be used for the Degree element only if the dataset passes all the requirements described in the abstract test suite presented in Annex A. The Specification element should be given as follows:
- title: “INSPIRE Data Specification on <Theme Name> – Draft Guidelines”
- date:
  - dateType: publication
  - date: 2011-06-15

Open issue 6: Conformance testing is still an open issue under discussion.

Instructions on conformance testing and a common abstract test suite (including detailed instructions on how to test specific requirements) will be added at a later stage.

This may also lead to an update of the recommendations on how to fill the conformity metadata element.

8.4.2 Lineage

Recommendation 7 Following the ISO 19113 Quality principles, if a data provider has a procedure for quality validation of their spatial data sets then the data quality elements listed in the Chapters 7 and 8 should be used. If not, the *Lineage* metadata element (defined in Regulation 1205/2008/EC) should be used to describe the overall quality of a spatial data set.

According to Regulation 1205/2008/EC, lineage "is a statement on process history and/or overall quality of the spatial data set. Where appropriate it may include a statement whether the data set has been validated or quality assured, whether it is the official version (if multiple versions exist), and whether it has legal validity. The value domain of this metadata element is free text".

The Metadata Technical Guidelines based on EN ISO 19115 and EN ISO 19119 specify that the statement sub-element of LI_Lineage (EN ISO 19115) should be used to implement the lineage metadata element.

Recommendation 8 To describe the transformation steps and related source data, it is recommended to use the following sub-elements of LI_Lineage:
- For the description of the transformation process of the local to the common INSPIRE data structures, the LI_ProcessStep sub-element should be used.
- For the description of the source data the LI_Source sub-element should be used.

NOTE 1 This recommendation is based on the conclusions of the INSPIRE Data Quality Working Group to avoid overloading of the overall lineage statement element with information on the transformation steps and related source data.

NOTE 2 In order to improve the interoperability, domain templates and instructions for filling these free text elements (descriptions) may be specified in an Annex of this data specification.

Open issue 7: The suggested use of the LI_Lineage sub-elements needs to be discussed as part of the maintenance of the INSPIRE metadata Technical Guidelines.

8.4.3 Temporal reference

According to Regulation 1205/2008/EC, at least one of the following temporal reference metadata elements shall be provided: temporal extent, date of publication, date of last revision, date of creation. If feasible, the date of the last revision of a spatial data set should be reported using the *Date of last revision* metadata element.

9 Delivery

9.1 Delivery medium

DS Requirement 2	Data conformant to this INSPIRE data specification shall be made available through an INSPIRE network service.

DS Requirement 3	All information that is required by a calling application to be able to retrieve the data through the used network service shall be made available in accordance with the requirements defined in the Implementing Rules on Network Services.

EXAMPLE 1 Through the Get Spatial Objects function, a download service can either download a pre-defined data set or pre-defined part of a data set (non-direct access download service), or give direct access to the spatial objects contained in the data set, and download selections of spatial objects based upon a query (direct access download service). To execute such a request, some of the following information might be required:

- the list of spatial object types and/or predefined data sets that are offered by the download service (to be provided through the Get Download Service Metadata operation),
- and the query capabilities section advertising the types of predicates that may be used to form a query expression (to be provided through the Get Download Service Metadata operation, where applicable),
- a description of spatial object types offered by a download service instance (to be proviced through the Describe Spatial Object Types operation).

EXAMPLE 2 Through the Transform function, a transformation service carries out data content transformations from native data forms to the INSPIRE-compliant form and vice versa. If this operation is directly called by an application to transform source data (e.g. obtained through a download service) that is not yet conformant with this data specification, the following parameters are required:
Input data (mandatory). The data set to be transformed.

- Source model (mandatory, if cannot be determined from the input data). The model in which the input data is provided.
- Target model (mandatory). The model in which the results are expected.
- Model mapping (mandatory, unless a default exists). Detailed description of how the transformation is to be carried out.

9.2 Encodings

9.2.1 Default Encoding(s)

DS Requirement 4	Data conformant to the application schema(s) defined in section 5 shall be encoded using the encoding(s) specified in this section.

9.2.1.1. Default encoding for application schema Soil - Core

Name: Soil - Core GML Application Schema
Version: version 2.0, GML, version 3.2.1
Specification: D2.8.**III.3** Data Specification on **SOIL** – Draft Guidelines
Character set: UTF-8

The GML Application Schema is distributed in a zip-file separately from the data specification document.

10 Data Capture

There is no specific guidance required with respect to data capture.

Member States may capture Soil data using their own processes and according to their own specifications and requirements, provided they can perform the necessary transformations to provide INSPIRE-compliant *Soil* data to fulfill INSPIRE Directive obligations.

11 Portrayal

This clause defines the rules for layers and styles to be used for portrayal of the spatial object types defined for this theme.

In section 11.1, the *types* of layers are defined that are to be used for the portrayal of the spatial object types defined in this specification. A view service may offer several layers of the same type, one for each dataset that it offers on a specific topic.

Section 11.2 specifies the styles that shall be supported by INSPIRE view services for each of these layer types.

In section 11.3, further styles can be specified that represent examples of styles typically used in a thematic domain. It is recommended that also these styles should be supported by INSPIRE view services, where applicable.

Where XML fragments are used in these sections, the following namespace prefixes apply:
- sld="http://www.opengis.net/sld" (WMS/SLD 1.1)
- se="http://www.opengis.net/se" (SE 1.1)
- ogc="http://www.opengis.net/ogc" (FE 1.1)

IR Requirement 11	If an INSPIRE view services supports the portrayal of data related to the theme **SOIL**, it shall provide layers of the types specified in this section.

DS Requirement 5	If an INSPIRE view network service supports the portrayal of spatial data sets corresponding to the spatial data theme **SOIL**, it shall support the styles specified in section 11.2. If no user-defined style is specified in a portrayal request for a specific layer to an INSPIRE view service, the default style specified in section 11.2 for that layer shall be used.

Recommendation 9	In addition to the styles defined in section 11.2, it is recommended that, where applicable, INSPIRE view services also support the styles defined in section 11.3.

11.1 Layers to be provided by INSPIRE view services

Layer Name	Layer Title	Spatial object type(s)	Keywords
SO.SoilComplex	Soils	SoilComplex	Soil-Complex, Dominant Soil Typological Unit, Soil Mapping Unit, SMU, Soil Type
SO.SoilPlot	Soil Plot	SoilPlot	Soil Plot, Bore Hole, Boring, Bore Hole Location, Soil Profile Location
SO.SoilSite	Soil Site	SoilSite	Soil site, Contaminated area, Soil survey, Soil Monitoring Area, Soil Investigation Area
SO,SoilTheme	Soil *<theme>*	SoilThematicObject	Soil Property Map, Soil Thematic Map, *<theme>*

11.1.1 Layers organisation

The layers SO.SoilPlot and SO.SoilSite can be organized in one group representing Soil surveys (SO.SoilSurvey). The Hierarchy will be that soil plots are located inside soil plots. This will be only useful if the areas where surveys are carried out within a region and/or country are somehow connected.

SO.SoilComplex and SO.SoilTheme are not grouped.

11.2 Styles to be supported by INSPIRE view services

11.2.1 Styles for the layer SO.SoilComplex

Style Name	SO.SoilComplex.Default
Default Style	yes
Style Title	Basic Soil Complex Default style
Style Abstract	This style is the generic style for visualising the boundaries of soil complexes. For visualising Soil Complexes on a map means in practice up to several hundreds of different legend units. Therefore this default style does not specify any colours to represent the different legend units, but instead proposed to use Polygon geometries to be rendered using a solid black outline with a stroke width of 1 pixel. Each polygon is then labelled with the Label name(soilComplexLabel) in black colour. In many cases annotation is already used in practise. This Default syle uses the WRB naming conventions in which the dominant soil type (DerivedSoilProfile) name will be used to annotate the soil mapping units.

Symbology	The SLD specifying the symbology is distributed in a file separately from the data specification document.
	
	`<sld:NamedLayer>`
	`  <se:Name>SO.SoilComplex</se:Name>`
	`  <sld:UserStyle>`
	`  <se:Name>INSPIRE_Default</se:Name>`

	<sld:IsDefault>1</sld:IsDefault> <se:FeatureTypeStyle version="1.1.0"> <se:Description> <se:Title> Soil complex Default style </se:Title> <se:Abstract> This style is the generic style for visualising the boundaries of soil complexes. For visualising Soil Complexes on a map means in practice up to several hundreds of different legend units. Therefore this default style does not specify any colours to represent the different legend units, but instead proposed to use Polygon geometries to be rendered using a solid black outline with a stroke width of 1 pixel. Each polygon is then labelled with the Label name(soilComplexLabel) in black colour. In many cases annotation is already used in practise. This Default syle uses the WRB naming conventions in which the dominant soil type (DerivedSoilProfile) name will be used to annotate the soil mapping units.</se:Abstract> </se:Description> <se:FeatureTypeName>SoilComplex</se:FeatureTypeName> <se:Rule> <se:PolygonSymbolizer> <se:Geometry> <ogc:PropertyName>shape</ogc:PropertyName> </se:Geometry> <se:Fill/> <se:Stroke/> </se:PolygonSymbolizer> </se:Rule> </se:FeatureTypeStyle> </sld:UserStyle> </sld:NamedLayer> **Open issue 8:** For annotation the SLD still has to be finalized
Minimum & maximum scales	<min scale> - <max scale>

11.3 Other recommended styles

11.3.1 Styles for the layer SO.SoilComplex

Style Name	**SO.SoilComplex.WRB**
Style Title	Soil Complex style as is used by the WRB
Style Abstract	*For visualising the soil map according to the WRB classification and representation a generic style is defined to visualize the soil polygons on the map* **Open issue 9:** The style is specified in a document and has to be transformed to a proper SLD
Symbology	
Minimum & maximum	250.000 – up

scales	

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[ISO 19103] ISO/TS 19103:2005, Geographic information – Conceptual schema language

[ISO 19107] EN ISO 19107:2005, Geographic information – Spatial schema (ISO 19107:2003)

[ISO 19108] EN ISO 19108:2005 Geographic information - Temporal schema (ISO 19108:2002)

[ISO 19111] EN ISO 19111:2007 Geographic information - Spatial referencing by coordinates (ISO 19111:2007)

[ISO 19115] EN ISO 19115:2005, Geographic information – Metadata (ISO 19115:2003)

[ISO 19118] EN ISO 19118:2006, Geographic information – Encoding (ISO 19118:2005)

[ISO 19135] EN ISO 19135:2007 Geographic information – Procedures for item registration (ISO 19135:2005)

[ISO 19139] ISO/TS 19139:2007, Geographic information – Metadata – XML schema implementation

[OGC 06-103r3] Implementation Specification for Geographic Information - Simple feature access – Part 1: Common Architecture v1.2.0

Annex A
(normative)

Abstract Test Suite

Any dataset conforming to this INSPIRE data specification shall meet all requirements specified in this document.

Open issue 10: Conformance testing is still an open issue under discussion.

Instructions on conformance testing and a common abstract test suite (including detailed instructions on how to test specific requirements) will be added at a later stage.

Annex B
(informative)
Use cases

This Annex describes the Use Cases for the INSPIRE Soil theme and associated data specification.

During the participative process many stakeholders contributed with Use Cases and User Requirements. During the development of the Data Specification a selection of Use cases were worked out in detail to develop and check the model. In total 15 Use Cases were studied which covered the following fields:

- Agri-Environmental Indicators: 3
- Thematic maps:
  - National legislation 1
  - European use 1
  - National/regional/local use 5
- Contaminated sites
  - National legislation 4
- Soil Monitoring
  - National/regional/local use 1

They cover the categories EU legislation, National legislation, use at European level and use at National level. For most fields only a very few categories were present – mostly only use at National level.

The following Use cases were described:

Agri-Environmental Indicators:
- Use Case Environmental Indicator Soil Erosion
- Use Case Environmental Indicator Soil Quality
- Use Case Environmental Indicator Contaminated Sites

Thematic maps
- Land irrigation suitability in Navarra (Spain)
- Development of methodologies for soil salinity surveillance in the middle Ebro basin (Spain)
- MARS project
- Restrictions for N and P in agriculture
- Calculation threshold trace elements
- Use of Soil Scape Viewer
- Establishment Less Favoured Areas (France)

Contaminated sites
- Contaminated Land Register Austria
- Use Case drinking water and soil contamination
- Use Case Ecology and contamination
- Use Case Property and contamination

Soil Monitoring
- Use Case state of soil in Europe

The following table gives the relation of the Use Cases and the relevant legislation at the appropriate level:

Use Cases	***Agri-Environmental Indicators***:	- Use Case Environmental Indicator Soil Erosion	- Use Case Environmental Indicator Soil Quality	- Use Case Environmental Indicator Contaminated Sites	***Thematic maps***	- Land irrigation suitability in Navarra (Spain)	- Development of methodologies for soil salinity surveillance in the middle Ebro basin (Spain)	- yield forecasting within the MARS project	- Restrictions for N and P in agriculture	- Calculation threshold trace elements	- Use of Soil Scape Viewer	- Establishment Less Favoured Areas (France)	***Contaminated sites***	- Contaminated Land Register Austria	- Use Case drinking water and soil contamination	- Use Case Ecology and contamination	- Use Case Property and contamination	***Soil Monitoring***	- Use Case state of soil in Europe
Directives																			
CAP. Council regulation (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy.						●						●							
Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates form agricultural sources.									●										
Directive 200/60/EC of the European Parliament and of the council of 23 October 2000 establishing a framework for Community action in the field of water policy.									●	●				●					
Directive 2009/28/EC of the European Parliament and of the Council. Energy from renewable resources.												●							
Directive 86/278/EC of the European Parliament and of the Council. Sludge Directive.										●									
Directive 1999/31/EC of the European Parliament and of the Council of 26 April 1999 on the landfill and waste.														●	●	●			
Still under discussion: Less Favoured Areas (LFA) Intermediate areas. This regulation is aimed at better targeting of natural handicap payments COM (2009) 161.												●							
Proposed Soil Framework Directive							●							●	●	●	●		

B.1 Agri-Environmental Indicator – Soil Erosion

The European Council requested the Commission to report on the integration of environmental dimensions into Community sectoral policies. As a contribution to meeting this requirement for the agricultural sector, a list of agri-environmental indicators was initially developed with two Commission Communications in 2000 and 2001.

To improve, develop and compile at the appropriate geographical level the indicators identified then, the IRENA (Indicator Reporting on the integration of Environmental concerns into Agricultural policy) project was launched. It was a collaborative effort between the Directorate-General for Agriculture and Rural Development (DG AGRI), the Directorate-General for Environment (DG ENV), Eurostat, the Joint Research Centre (JRC) and the European Environment Agency (EEA) which was responsible for the co-ordination. The results of the IRENA operation were as a set of 42 indicators and sub-indicators and their 40 fact sheets for EU-15.

Following up the IRENA project, the Commission adopted the final list of 28 indicators in a Communication of 2006 ("Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy"). The approach outlined in this Communication was endorsed by the Council.

Important to note is that the Communication says:" … In this respect, the full involvement and commitment of the Member States, which are ultimately responsible for data collection, is necessary."

The same five partner institutions have agreed to develop and maintain this system of agri-environmental indicators and laid down the basis for cooperation in a Memorandum of Understanding. (see *http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators/introduction/history_partners*)

The indicators are currently under development by the five partners which make proposals that are then commented and approved by Member States in consultation meetings. In a sub-sequent operational phase, Eurostat will be responsible for the collection of the data from Member States.

How this will happen and at which level of detail (in the NUTS) still has to be decided.

One of the indicators is "soil erosion", defined as annual soil erosion risk by water.

The model proposed by JRC for the computation of this indicator is RUSLE. This is not consolidated yet.

RUSLE stands for Revised Universal Soil Loss Equation and, with a widespread acceptance, has become a major soil conservation planning tool in many countries in the world.

RUSLE and USLE can be expressed as follows $A = R * K * L * S * C * P$

Where
A = estimated average soil loss in tons per acre per year
R = rainfall-runoff erosivity factor
K = soil erodibility factor
L = slope length factor
S = slope steepness factor
C = cover-management factor
P = support practice factor

Use Case Description	
Name	*Agri-Environmental Indicator Soil Erosion*
Priority	*High*
Description	*Member States will need to provide soil erosion data to Eurostat, according to the RUSLE model*
Legal foundation(s)	• *Council conclusions (2006)* • *Commission Communication (2006)* • *Commission Communication (2001)* • *Commission Communication (2000)* • *Eurostat has the legal mandate to collect data from the Member States*
Pre-condition	*Availability of data that is required for computation of the indicators*
Flow of Events - Basic Path	
Step 1	*Member State collects the data that are needed to compute the soil erosion indicator*
Step 2	*Member State computes indicator*
Step 3	*Member State sends indicator to Eurostat*
Step 4	*Eurostat verifies and validates the data; Eurostat creates European indicator map*
Post-condition	*Not applicable*
Actors	
End-users	- *Member State* - *European Institutions* - *Citizen* - *Professional (Agri-environmental business)* - *Scientists*
Information provider(s)	*Member State local and national organizations*
Information processors(s)/Brokers	*Member State authorities responsible for the computation of the index*
Information Source Output *From Member States: Maps at NUTS-x level or raster format that show the distribution and value of the indicator.* *From Eurostat: Maps integrating all Member State indicator maps.*	
Description	
Thematic scope	*Soil*
Base datasets	*Base datasets are maps at NUTS-x level or rasters, that show the indicator*
Data provider	*Member States to Eurostat;* *Eurostat to citizen*

Use Case Description	
Scale, resolution	*NUTS-x level; in order to come to NUTS level aggregation, one can envisage various scales (e.g. 1:250,000) and resolutions (e.g. 1 km)*
Documentation	- *Legislation (see above)* - *Web site (see above)* - *Memorandum of Understanding (not public)*
External reference	*See web site*
Information Source Input *Data that allow the application of the approved model for the computation of the sub-indicators and the main indicator*	
Description	
Thematic scope	*Soil, land cover/use, climate, geomorphology*
Base dataset(s)	*To compute the indicators, the following information is needed:* - *climatic data (preferably with fine time-resolution): rainfall (as erosivity factor); temperature (sometimes)* - *soil texture (e.g. as %clay, %silt, %sand) and possibly also soil structure and permeability (e.g. as class values indicated in the USDA Soil Survey Manual 1951 (depending on the formulas used)) ,OM (e.g. as volume %)). It all depends on the formula's used; there are many.* - *geomorphology (slope, slope length)* - *landcover data* *As vector maps or as rasters (100m)*
Data provider(s)	- *climatic data should come from the national weather services;* - *soil data from the national organizations holding the soil data* - *geomorphology could come from SRTM or better.* - *CORINE at 100m for Landcover data*
Scale, resolution	*Preferably at a resolution of 100m*
Documentation	*March 2011: the proposed model will be finished and commented by Member States; then, the full documentation on the model will be ready.*
External reference	*none*

B.2 Agri-Environmental Indicator – Soil Quality

The European Council requested the Commission to report on the integration of environmental dimensions into Community sectoral policies. As a contribution to meeting this requirement for the agricultural sector, a list of agri-environmental indicators was initially developed with two Commission Communications in 2000 and 2001.

To improve, develop and compile at the appropriate geographical level the indicators identified then, the IRENA (Indicator Reporting on the integration of Environmental concerns into Agricultural policy) project was launched. It was a collaborative effort between the Directorate-General for Agriculture and Rural Development (DG AGRI), the Directorate-General for Environment (DG ENV), Eurostat, the Joint Research Centre (JRC) and the European Environment Agency (EEA) which was responsible for the co-ordination. The results of the IRENA operation were as a set of 42 indicators and sub-indicators and their 40 fact sheets for EU-15.

Following up the IRENA project, the Commission adopted the final list of 28 indicators in a Communication of 2006 ("Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy"). The approach outlined in this Communication was endorsed by the Council.

Important to note is that the Communication says:" … In this respect, the full involvement and commitment of the Member States, which are ultimately responsible for data collection, is necessary."

The same five partner institutions have agreed to develop and maintain this system of agri-environmental indicators and laid down the basis for cooperation in a Memorandum of Understanding. (see *http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators/introduction/history_partners*)

The indicators are currently under development by the five partners which make proposals that are then commented and approved by Member States in consultation meetings. In a sub-sequent operational phase, Eurostat will be responsible for the collection of the data from Member States.

How this will happen and at which level of detail (in the NUTS) still has to be decided.

The proposed indicator "soil quality" provides an account of the ability of soil to provide agri-environmental services through its capacities to perform its functions and respond to external influences.

In the agri-environmental context, soil quality describes:

- the capacity of soil to biomass production
- the input-need to attain optimal productivity
- the soil response to climatic variability
- carbon storage; filtering; buffering capacity

The main indicator is 'agri-environmental soil quality index', derived from four supporting indicators:

- productivity index
- fertilizer response rate
- production stability index
- soil environmental quality index

Use Case Description	
Name	*Agri-Environmental Indicator Soil Quality*
Priority	*High*
Description	*Member States will need to provide soil quality data to Eurostat, according to the model which is currently under development*
Legal foundation(s)	• *Council conclusions (2006)* • *Commission Communication (2006)* • *Commission Communication (2001)* • *Commission Communication (2000)* • *Eurostat has the legal mandate to collect data from the Member States*
Pre-condition	*Availability of data that is required for computation of the indicators*
Flow of Events - Basic Path	
Step 1	*Member State collects the data that are needed to compute the soil quality indicator*
Step 2	*Member State computes sub-indicator and main indicator*
Step 3	*Member State sends sub-indicator and indicator to Eurostat*
Step 4	*Eurostat verifies and validates the data; Eurostat creates European indicator map*
Post-condition	*Not applicable*
Actors	
End-users	- *Member State* - *European Institutions* - *Citizen* - *Professional (Agri-environmental business)* - *Scientists*
Information provider(s)	*Member State local and national organizations*
Information processors(s)/Brokers	*Member State authorities responsible for the computation of the index*
Information Source Output *From Member States: Maps at NUTS-x level that show the distribution and value of the indicator.* *From Eurostat: Maps integrating all Member State indicator maps.*	
Description	
Thematic scope	*Soil*
Base datasets	*Base datasets are maps at NUTS-x level or rasters that show* - *main indicator* - *sub-indicators*

Use Case Description	
Data provider	*Member States to Eurostat;* *Eurostat to citizen*
Scale, resolution	*NUTS-x level; in order to come to NUTS level aggregation, one can envisage various scales (e.g. 1:250,000) and resolutions (e.g. 1 km)*
Documentation	- *Legislation (see above)* - *Web site (see above)* - *Memorandum of Understanding (not public)*
External reference	*See web site*

Information Source Input

Data that allow the application of the approved model for the computation of the sub-indicators and the main indicator

Description	
Thematic scope	*soil, climate data, land cover/ land use*
Base dataset(s)	*To compute the indicators, the following information is needed:* - *climatic zone data* - *possibly temperature data* - *soil type (WRB),* - *available water capacity,* - *rooting depth,* - *depth to impermeable layer,* - *texture,* - *water regime* - *possibly soil OM/OC data* - *probably Landcover/landuse* *(see ANNEX-1 for more details)* *As vector maps or as rasters.*
Data provider(s)	- *climatic zone data provided by European Commission; temperature data to be provided by national weather services* - *soil datasets to be provided at national level* - *CORINE for Landcover/landuse*
Scale, resolution	*Depending on the final model and the selected NUTS-x level or selected raster resolution. (e.g. 1km)*
Documentation	*March 2011: the proposed model will be finished and commented by Member States; then, the full documentation on the model will be ready.*
External reference	*none*
`	

B.3 Progress in management of Contaminated sites (CSI 015) indicator

For many years, the EEA has been active in the development of indicators in relation to 'contaminated sites'. The term 'contaminated site' refers to a well-delimited area where the presence of **soil contamination** has been confirmed. After many meetings and discussions with representatives from Member States, one possible indicator was defined and agreed upon: "Progress in management of contaminated sites (CSI 015)". Although it is related to soil, the indicator does not require soil data as such.

More details can be found on:
http://www.eea.europa.eu/data-and-maps/indicators/progress-in-management-of-contaminated-sites

In 2008, the responsibility for data collection related to this indicator from Member States, passed from EEA to JRC.

Detailed structured description of the Use Case

For the TWG Soil, the EEA Indicator CSI015 "Progress in the Management of Contaminated Sites" was investigated as a candidate for a Use Case.

As this indicator does not use actual contaminated sites data, but only statistical data in association with the number and status of contaminated site and with the progress in cleaning-up contaminated sites in a country, the TWG decided not to retain it in the list of suitable Use Cases.

B.4 Land Irrigation Suitability for Navarra (Spain)

This Use Case explains the system followed in Navarre (Spain) for establishing the land irrigation suitability at a scale of 1:25.000.

Irrigation projects generally involve costly inputs and improvements, such as engineering works, irrigation and drainage networks, land clearing and levelling, and others. The estimation of the irrigation capacity of the land is basic for the development plans of a region, taking into account that the irrigated lands are the most productive ones, especially in the arid and semi-arid regions.

The essential parameters to consider in an irrigation suitability assessment are: climate, soil, drainage, hydrology, topography, vegetation, as well as, economic, social and political reasons. Therefore, a multidisciplinary team is needed for a regional irrigation project plan.

One of these actors in Navarre is the Department of Rural Development and Environment of the Government of Navarre, who is in charge, together with Tracasa, of the elaboration of the land irrigation suitability map from a soil point of view. This team decided to employ an adapted version of the USBR (United States Reclamation Bureau) land classification system. This system recognizes 7 land classes:

- Class 1: Arable lands, suitable for irrigated farming, without use limitations.
- Class 2: Arable lands, suitable for irrigated farming, with slight limitations.
- Class 3: Arable lands, suitable for irrigated farming, with moderate limitations.
- Class 4: Arable lands, suitable for a fixed irrigated farming and employing special irrigation systems, with high limitations.
- Class 5: A class requiring special reports to establish whether it is suitable or not for irrigation.
- Class 6: Arable lands, non-suitable for irrigated farming or non-arable lands.
- Class IU: Non-productive lands.

Subclasses indicate the reason for the land being downgraded to a lower class. These deficiencies are related to soil, topography and/or farm drainage:

- **Soil**: effective rooting depth and texture, carbonate content, stoniness, sodicity and salinity, in the topsoil and/or subsoil.
- **Topography**: slope.
- **Drainage**: ground water table depth and impermeable layer depth.

Soil mapping units are reclassified according to the parameters above mentioned as it is shown in Figure 1. Afterwards, this information is intersected with the land cover and slope map (Figure 2) and the product is the “Land irrigation suitability map” at a scale of 1:25.000. For these automated GIS processes a suite of applications (Geobide) have been specifically designed in Tracasa.

The “Land irrigation suitability map” is made at a scale of 1:25.000, therefore, and depending on the case, for further and more detailed information, additional works should be carried out.

		Subsoil lower depth	The most limiting factor of the Topsoil or Subsoil				Topsoil texture	Subsoil texture: -**Other soil** -Sandy soils	
		SOIL					**TOPOGRAPHY**	**DRAINAGE**	
Parametres and limits		Topsoil texture	Effective rooting depth (cm)	Carbonate content (%)	Coarse fragments (%)	Sodicity (SAR)	Salinity (ds/m)	Slope (%)	Ground water table depth (cm)	Impermeable layer depth (cm)
Classes and Subclasses	**1**	1	>100	<35	<5	<14	<2	**<2** **<4**	**>150** >125	>210
	2s	2	>75	<50	<10	<14	<4	**<2** **<4**	**>150** >125	>210
	2st							**2-5** **4-10**		
	2sd							**<2** **<4**	**>100** >75	>180
	2std							**2-5** **4-10**		
	3s	3	>50	<65	<25	<14	<8	**<2** **<4**	**>150** >125	>210
	3st							**5-10** **10-20**		
	3sd							**<2** **<4**	**>50** >50	>150
	3std							**5-10** **10-20**		
	4s	1, 2 or 3	>25	>65	<50	<26	<16	**<2** **<4**	**>150** >125	>210
	4st							**10-20** **20-25**		
	4sd							**<2** **<4**	**>25** >25	>45
	4std							**10-20** **20-25**		
	6	1, 2 or 3	<25		>50	>26	>16	**>20** **>25**	**<25** <25	<45

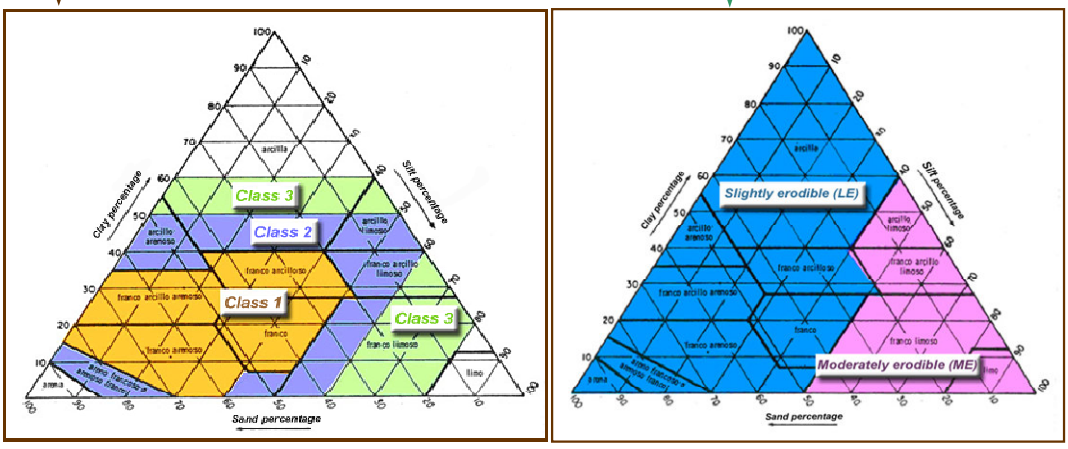


***Figure 1**: Reclassification of Soil Mapping Units according to soil parameters, topography and drainage.*

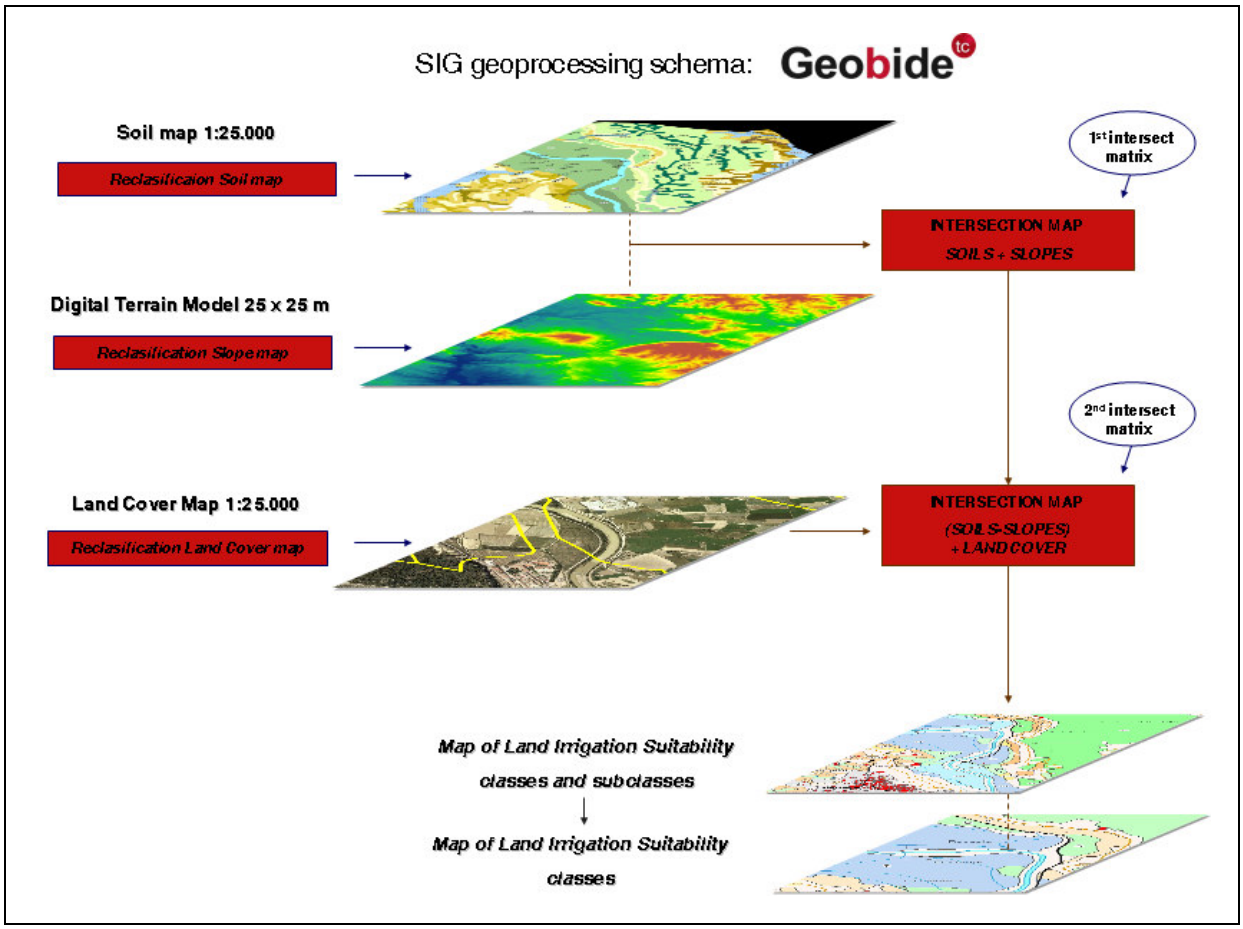


Figure 2: Schema of the GIS geoprocessing in Geobide.

Use Case Description	
Name	Land irrigation suitability in Navarre (Spain).
Priority	Medium
Description	Land irrigation suitability maps in Navarre (1:25.000) are elaborated following the methodology proposed by the USBR (Unites States Bureau of Reclamation), but adapted to the specific conditions of Navarre (Spain). The objective is to classify the land according to soil properties, topography, drainage and land cover. From the reclassification of this information and its intersection in GIS land irrigation suitability maps are obtained. These maps are elaborated employing a suite of applications specifically designed for that purpose (Geobide) and are finally published in a viewer.
Legal Foundation	No legal base.
Pre-condition	None.
Actors	
End-users	Governmental bodies and public institutions, farmers, collective irrigation organisations…
Information provider(s)	Tracasa, Government of Navarre.
Information processors(s)/Brokers	Tracasa, Government of Navarre.
Flow of Events – Basic Path	
Step 1	A soil map of a certain area is elaborated: field work, photointerpretation and map edition processes are made.

Use Case Description	
Step 2	The soil mapping units (SMU) are reclassified according to soil, topography and drainage properties. **Soil**: effective rooting depth and texture, carbonate content, stoniness, sodicity and salinity, in the topsoil and/or subsoil (the most limiting factor between both the topsoil and subsoil is the one taken into account). **Topography**: slope. **Drainage**: ground water table depth and impermeable layer depth. The methodology used for this reclassification is an adaptation for Navarre based on the one proposed by the USBR. This reclassification is automatically done by an own application, which takes into account, from all the surveys done in each SMU for a studied area, all these parameters above mentioned.
Step 3	A slope map based on the DTM25 is elaborated according to 7 range values.
Step 4	The reclassified soil map and slope map are intersected in GIS using the application Geobide.
Step 5	The land cover map is reclassified according to 3 uses: forestry, arable land and non-productive land.
Step 6	The reclassified land cover map is intersected in GIS with the soil-slope cross-map (Geobide).
Step 7	The land irrigation suitability classes and subclasses' map is obtained. Its mapping units contain information about their limiting factor (soil, topography and/or drainage).
Step 8	After getting into groups the previous subclasses into classes, the land irrigation suitability classes' map is obtained. The legend of this product is the following one (no information on the limiting factor is reflected): **Class 1**: Arable lands, suitable for irrigated farming, without use limitations. **Class 2**: Arable lands, suitable for irrigated farming, with slight limitations. **Class 3**: Arable lands, suitable for irrigated farming, with moderate limitations. **Class 4**: Arable lands, suitable for a fixed irrigated farming and employing special irrigation systems, with high limitations. **Class 5**: A class that requires special reports to establish whether it is suitable or not for irrigation. **Class 6**: Arable lands, non-suitable for irrigated farming or non-arable lands. **Class IU**: Non-productive lands.
Step 9	These 2 maps are published in the VisorSITNA viewer (this viewer is available for governmental bodies and public institutions).
Information source Input : Soil map of Navarre	
Description	The map contains soil information of the municipalities of Navarre (1:25.000) (whole region not mapped yet).
Dataset(s)	The soil map of Navarre and its related soil data base are needed to obtain land irrigation maps. Specifically, the following parameters of the soil data base are used: - Topsoil texture (simplification of the texture triangle: % clay, % silt and % sand) - Effective rooting depth (cm) - Mean carbonate content (%), coarse fragment content (%), sodicity (SAR) and electric conductivity of the soil saturate extract (dS/m), in the topsoil and/or subsoil.
Data provider	Tracasa, Government of Navarre.
Geographic scope	Regional (Navarre, Spain).
Thematic scope	Soil
Scale, resolution	Polygonal data source, at a scale of 1:25.000.
Delivery	n/a
Documentation	Public. Soil maps (VisorSITNA viewer) and reports (in paper and/or CD,

Use Case Description	
	available at the Government of Navarre and Tracasa).
Information source Input: Land cover map of Navarre	
Description	This land cover map covers the whole region of Navarre (Spain) at a scale of 1:25.000.
Dataset(s)	Land cover map of Navarre and its related database.
Data provider	Tracasa, Government of Navarre.
Geographic scope	Regional (Navarre, Spain).
Thematic scope	Soil, land cover, land use.
Scale, resolution	Polygonal data source, at a scale of 1:25.000.
Delivery	n/a
Documentation	The land cover map is available at IDENA (*http://idena.navarra.es*) and in the VisorSITNA viewer.
Information source Input: DTM25 of Spain	
Description	The Digital Terrain Model based on a grid of 25 m covers the whole national territory of Spain and it's obtained from the National Topographic Map 1:25.000 (MTN25).
Dataset(s)	DTM25
Data provider	Instituto Geográfico Nacional (IGN).
Geographic scope	National (Spain).
Thematic scope	Soil, geographical grid system and elevation.
Scale, resolution	Raster data source, with a resolution of 25 metres.
Delivery	n/a
Documentation	n/a
Information source Output: Land irrigation suitability classes' and subclasses' map	
Description	The map classifies the land in up to 16 different subclasses and specifies whether the limitation to set up an irrigation project is related to the soil itself, drainage or topography.
Dataset(s)	Land irrigation classes and subclasses' map 1:25.000 and its related dataset.
Data provider	Tracasa, Government of Navarre.
Geographic scope	Regional (Navarre, Spain)
Thematic scope	Soil, agricultural facilities and area management zones.
Scale, resolution	Polygonal data source, at a scale of 1:25.000
Delivery	n/a
Documentation	Public. Land irrigation maps (VisorSITNA viewer) and reports (in paper and/or CD, available at the Government of Navarre and Tracasa).
Information source Output: Land irrigation suitability classes' map	
Description	This map classifies the terrain in up to 7 different irrigation suitability classes, but it doesn't specify the limitations of each class.
Dataset(s)	Land irrigation suitability classes' map (1:25.000) and its related data base.
Data provider	Tracasa, Government of Navarre.
Geographic scope	Regional (Navarre, Spain)
Thematic scope	Soil, agricultural facilities and area management zones.
Scale, resolution	Polygonal data source, at a scale of 1:25.000.
Delivery	n/a
Documentation	Public. Land irrigation maps (VisorSITNA viewer) and reports (in paper and/or CD, available at the Government of Navarre and Tracasa).

B.5 Development of methodologies for soil salinity surveillance in the middle Ebro basin (Spain)

Subtitle: Development and validation of methodologies based on territorial information systems (remote sensing, GIS, and electromagnetic sensing systems) for identification, prospection and surveillance of salt-affected areas in the middle Ebro basin using information derived from soil maps as ground truth.

The European Commission proposed a framework and common objectives to prevent soil degradation, preserve soil functions and remediate degraded soil (European Thematic Strategy for Soil Protection[14] (ETSSP). Under this proposal, risk areas and polluted sites must be identified and provision should be made to remediate degraded soil.

The measures included in the proposal for a Soil Framework Directive[15] (SFD) include obligatory identification by Member States of areas at risk of erosion, organic matter decline, compaction, **salinization** and landslides, or where the degradation process is already underway. Member States must set objectives and adopt programs of measures to reduce these risks and to address the effects they have.

This Strategy suggests the need to protect the soil, among others, from ***soil salinization*** or the accumulation of soluble salts in the soil at such levels that reduces soil's physical-chemical quality, crop yields and the environmental quality (salinization of surface- and ground-waters).

This use case is part of a Spanish research project (RTA2008-00083-C02-00) under development (2009-2011), entitled "*Soil salinity prospection in the middle Ebro basin and design of its spatial-temporal surveillance through territorial information technologies*". It is a coordinated project with two subprojects, one in Navarra (RTA2008-00083-C02-01; whose main research is Mª Esperanza Amezketa), and another one in Aragón (RTA2008-00083-C02-02; whose main research is Mª Auxiliadora Casterad).

This research project is tackling the more relevant aspects of the ETSSP with respect to soil salinization, with the objective of researching and establishing methodologies for soil salinity survey and appropriate systems for its spatial-temporal surveillance. The study considers, for pre-selected study areas in the middle Ebro basin (Navarra and Aragón), the analysis of the spatial distribution of soil salinity and of the geomorphologic and hydro-geologic factors and processes determining of its development, as well as the design of their spatial-temporal surveillance through territorial information technologies (classical soil prospection, electromagnetic induction sensors associated to global positioning systems-MGES, remote sensing, and geographic information systems). The methodologies are being contrasted, evaluated and adapted to the natural and agrarian landscape. The information that will be generated will contribute to better soil management and soil uses and territory planning, and to the systematizing of soil protection policies required by the current ETSSP and the future SFD.

This project is financially supported by the INIA (Instituto Nacional de Investigación Agraria y Alimentaria, RTA2008-00083-C02-00), the Department of Environment and Rural Development of the Government of Navarra (RTA2008-00083-C02-01), the Ministry of Science and Innovation (Spain) and the European Social Fund (SubProgramme Torres Quevedo, PTQ-08-03-07315).

This use case shows three examples included in this research project.

[14] Commission Communication of 22 September 2006 entitled "European Thematic Strategy for Soil Protection (ETSSP)" [COM(2006) 231 final - Not published in the Official Journal].

[15] Proposal for a European Parliament and Council Directive of 22 September 2006 setting out a framework for soil protection and amending Council Directive 2004/35/EC. (SDF)

Use Case Description	
Name	Methodologies for soil salinity surveillance in the middle Ebro basin (Spain): Development and validation of methodologies based on territorial information systems (remote sensing, GIS, and electromagnetic sensing systems) for identification, prospection and surveillance of salt-affected areas in the middle Ebro basin (Spain) using information derived from soil maps as ground truth.
Priority	High
Description	This use case shows three examples of usage of soil map information for the objective of researching methodologies for soil salinity prospection and its spatial-temporal surveillance: 1. Using soil map information (soil taxonomic and geomorphic units) for stratifying the territory for ultimately directing the regional soil salinity survey and calibration with electromagnetic induction sensing systems (EMISS). 2. Using soil map information (soil salinity map at regional scale) as ground truth for validating a GIS methodology for identification of areas susceptible for salt-accumulation (primary salinization) from (1) information derived from Digital Terrain Models (DTM) and (2) additional layers of information which can influence soil salinity. 3. Using soil map information (soil salinity map at regional scale, and detailed soil salinity maps obtained with EMISS) as ground truth for validating a methodology based on remote sensing for (i) identifying and mapping persistent problematic areas from the agricultural point of view and (ii) optimizing the selection of areas for soil salinity prospection and/or monitoring.
Legal Foundation	No legal base (yet). The Soil Framework Directive is not approved. However, the European Soil Thematic Strategy for Soil Protection already recommends the development of information like this. Commission Communication of 22 September 2006 entitled "European Thematic Strategy for Soil Protection" [COM (2006) 231 final - Not published in the Official Journal]. Proposal for a European Parliament and Council Directive of 22 September 2006 setting out a framework for soil protection and amending Council Directive 2004/35/EC.
Pre-condition	Soil Framework Directive has to be approved for EU.
Actors	
End-users	Governmental bodies and public institutions at regional and/or national level, soil researchers, farmers, collective irrigation organisations, etc.
Information provider(s)	Government of Navarra, Tracasa, Government of Aragón, Centro de Investigación y Tecnología Agroalimentaria de Aragón (CITA)
Information processors(s)/Brokers	Tracasa, CITA-Aragón

Example 1:

Using soil map information for stratifying the territory for directing the regional soil salinity survey and calibration with electromagnetic induction sensing systems (EMISS)

This work was done as a pilot study for a very few selected soil cartographic units, in a small study area

Electromagnetic sensors' readings are influenced by the physical and chemical properties of soils. A way for tackling the high variability of those properties is stratifying EMISS prospection and soil sampling as a function of soil-types.

Flow of Events – Basic Path

Step 1	Use of soil maps to characterize the high variability of soil physical-chemical properties at regional level, to identify soil-types and to stratify the territory. Use the soil cartographic units (SCU) to direct the soil salinity survey with EMISS (SCU incorporate taxonomic, geomorphic and geologic soil information).
Step 2	Selection of some of the most susceptible SCU for presenting salinity problems (according to geographic position, geologic materials, etc) for EMISS prospection and calibration. Prospection of soil cartographic units (SCU) with EMISS when soil water content is close to field capacity (a few days after some rains or irrigation events).

Step 3	Calibration of the sensor (EMISS) to convert the apparent soil electrical conductivity (ECa) into ECe values.
	- Selection of a reduced number of sampling points at each SCU, covering the full range of EMISS readings
	- Soil sampling at different depths increments
	- Soil analysis: Soil parameters to be analyzed in laboratory:
	  - Electrical conductivity of the soil saturation extract (ECe)
	  - Soil water content during prospection (%)
	  - Soil texture (soil saturation percentage, SP)

Step 4	Obtaining calibration equations at each selected SCU for assigning soil salinity phases to the EMISS readings: Four soil salinity classes can be established according to the maximum ECe measured in the soil profiles: - Non-saline zones (NS, ECe 4 < dS m^{-1}) - Slightly saline zones (SS, 4 ≤ ECe ≤ 8 dS m^{-1}) - Moderately saline zones (MS, 8 < CEe < 16 dS m^{-1}) - Strongly saline zones (StS, ECe ≥ 16 dS m^{-1})
Step 5	Assigning soil salinity phases to EMISS readings for selected SCU: EMISS readings (ECa) must be converted into soil salinity classes according to the calibration equation and to the threshold ECa values equivalent to ECe values of 4, 8 and 16 dS m^{-1}.
Post-condition	

Information source Input : Soil maps at 1:25.000

Description	The map contains soil information for the pilot areas at a scale of 1:25.000.
Dataset(s)	Information employed: - Soil cartographic units (SCU), which incorporate information about soil taxonomy, geomorphic units and geologic materials
Data provider	Government of Navarra, Tracasa,

Geographic scope	Regional
Thematic scope	Soil
Scale, resolution	Polygonal data source, at a scale of 1:25.000.
Delivery	n/a
Documentation	Public. Soil maps (VisorSITNA viewer) and reports (in paper and/or CD, available at the Government of Navarra and Tracasa).
External reference	n/a
Information source Output: Map of salt-affected areas	
Description	The map has information about soil salinity phases
Dataset(s)	Map of salt-affected areas and its related database.
Data provider	Government of Navarra, Tracasa,
Geographic scope	Regional, very small pilot areas
Thematic scope	Soil
Scale, resolution	Polygonal data source, at a scale of 1:25.000
Delivery	n/a
Documentation	n/a
External reference	n/a
Information source Output: Sensor calibration equations	
Description	Calibration equations for the studied soil cartographic units (SCU)
Dataset(s)	
Geographic scope	Local, one for each SCU.
Data provider	Tracasa,
Thematic scope	Soil
Scale, resolution	n/a
Delivery	n/a
Documentation	n/a
External reference	n/a

Example 2: Using soil map information as ground truth for validating a GIS methodology for identification of areas susceptible for salt-accumulation (primary salinization)	
Flow of Events – Basic Path	
Step 1	Selection of pilot study areas
Step 2	Obtaining several layers/maps from digital elevation model: slope, curvature, plan curvature, wetness index, etc
Step 3	Intersection of several information in a GIS project for the pilot areas: information derived from DTM (slope, curvature, plan curvature, wetness index, etc), geomorphologic units, parental material,
Step 4	Validation of the methodology based on GIS by employing soil map information (soil salinity maps) as ground truth.
Post-condition	
Information source Input : Soil map at 1:25.000	
Description	The map contains soil information of the pilot areas at a scale of 1:25.000.
Dataset(s)	Information employed: - Soil salinity map derived from the soil map - Soil geomorphologic units derived from the soil map - Parental material (aluvial material, etc) derived from the soil map
Data provider	Government of Navarra, Tracasa.
Geographic scope	Regional
Thematic scope	Soil
Scale, resolution	Polygonal data source, at a scale of 1:25.000.
Delivery	n/a
Documentation	Public. Soil maps (VisorSITNA viewer) and reports (in paper and/or CD, available at the Government of Navarra and Tracasa).
External reference	n/a
Information source Input: Digital Terrain Model (DTM)	
Description	DTM of 5x5 m
Dataset(s)	Maps derived from DTM: maps of slope, curvature, profile curvature, plain curvature, wetness index etc., 25m x 25m
Data provider	Tracasa.
Geographic scope	Small pilot areas (few thousands of hectares) in Navarra (Spain)
Thematic scope	
Scale, resolution	DTM (5m x 5m), maps derived from DTM (25 x 25m)
Delivery	n/a
Documentation	
Information source Output: Map of risk for presenting salinity accumulation (primary salinization)	
Description	Maps with two classes (low and medium/high) of risk for presenting salt

	accumulation (primary salinization). This information could be used to help reducing areas that do not need to be prospected/monitored for soil salinity. These maps, complemented with other maps or information (e.g. derived from remote sensing), could be used for optimizing areas for salinity prospection and monitoring.
Dataset(s)	Map of risk for presenting salinity accumulation and its related database.
Data provider	Tracasa.
Geographic scope	Regional, small pilot areas in Navarra (Spain)
Thematic scope	Soil.
Scale, resolution	
Delivery	n/a
Documentation	n/a
External reference	n/a
Information source Output: Methodology for assessing the risk for soil salinity accumulation (primary salinization)	
Description	GIS based methodology to be used for complementing other methodologies, such as remote sensing, in order to optimize the selection of areas for soil salinity prospection and/or monitoring.
Dataset(s)	
Geographic scope	
Data provider	Tracasa,
Thematic scope	Soil
Scale, resolution	n/a
Delivery	n/a
Documentation	n/a
External reference	n/a

Example 3:

Using soil map information as ground truth for validating a methodology based on remote sensing for (i) identifying and mapping problematic areas from the agricultural point of view and (ii) optimizing the selection of areas for soil salinity prospection and/or monitoring.

Localizing by remote sensing areas with persistent agricultural problems (over several years) can help to discriminate salt-affected areas as well as to optimize the selection of areas for soil salinity prospection and/or monitoring.

Flow of Events – Basic Path

Step 1	Selection of pilot areas for the study.
Step 2	Calculation of NDVI from Landsat images for the pilot areas over the time.
Step 3	Identification of persistently problematic areas from the agricultural point of view, using the NDVI information. Repetition of the methodology for several years and analysis of the persistence of the problems: Identification of areas with persistent low productivity over the years.
Step 4	Validation of the methodology based on remote sensing by employing soil map information (soil salinity map derived from soil maps at regional scale, and detailed soil salinity maps obtained with EMISS) as ground truth.
Post-condition	

Information source Input : Soil maps at 1:25.000

Description	The map contains information about the salt-affected areas in the pilot areas at a scale of 1:25.000.
Dataset(s)	The map of the salt-affected areas has information about four soil salinity classes established from the maximum electrical conductivity of the soil saturation extract (ECe, dS/m) measured in the soil profiles: The four soil salinity classes are: - Non-saline zones (NS, ECe 4 < dS m^{-1}) - Slightly saline zones (SS, 4 ≤ ECe ≤ 8 dS m^{-1}) - Moderately saline zones (MS, 8 < CEe < 16 dS m^{-1}) - Strongly saline zones (StS, ECe ≥ 16 dS m^{-1})
Data provider	Government of Navarra, Tracasa, Government of Aragón, Centro de Investigación y Tecnología Agroalimentaria de Aragón (CITA).
Geographic scope	Pilot study areas in Navarra and Aragón (Spain)
Thematic scope	Soil, agriculture
Scale, resolution	Polygonal data source, at a scale of 1:25.000.
Delivery	n/a
Documentation	Navarra: Public. Soil maps (VisorSITNA viewer) and reports (in paper and/or CD, available at the Government of Navarra and Tracasa). Aragón: Reports (in paper and/or CD), available at the Government of Aragón and CITA
External reference	n/a

Information source Input: Other maps

Description	
Dataset(s)	- Cadastre 1:5.000 - SIGPAC (Land cover) 1:5.000 - Maps of soil crops established from remote sensing (Landsat, at resolution of 30m x 30m), declarations of farmers and inspections in the field.
Data provider	Government of Navarra, Tracasa, Government of Aragón, CITA
Geographic scope	Pilot areas in Navarra and Aragon (Spain)
Thematic scope	Soil, land cover, land use, cadastre
Scale, resolution	Polygonal data source, the scale depends on the layer
Delivery	n/a
Documentation	In Navarra, the land cover map and the cadastre are available at IDENA (*http://idena.navarra.es*) and in the *VisorSITNA* viewer. In Aragón: Sistema de Información Territorial de Aragón (SITAR; *http://sitar.aragon.es/*); Centro de Documentación e Información Territorial de Aragón, Government of Aragón,
Information source Input: Remote sensing images	
Description	Landsat images for different dates within a year. The same information (Landsat images for different dates within a year) for several years.
Dataset(s)	
Data provider	Government of Navarra, Tracasa, Government of Aragón, CITA
Geographic scope	Pilot study areas in Navarra and Aragón (Spain)
Thematic scope	
Scale, resolution	30m x 30m
Delivery	n/a
Documentation	n/a
External reference	n/a
Information source Output: Maps of areas with persistent agricultural problems (low productivity)	
Description	Raster maps (25 m x 25m) of areas that have persistent problems from the agricultural point of view (low productivity), which can be seen as areas with possible problems of soil salinity. These maps, combined with other information, could be used for optimizing areas for salinity prospection and monitoring.
Dataset(s)	
Geographic scope	Pilot study areas in Navarra and Aragón (Spain)
Data provider	Government of Navarra, Tracasa, Government of Aragón, CITA
Thematic scope	Soil, agriculture
Scale, resolution	Regional, raster maps 25m x 25m
Delivery	n/a
Documentation	n/a
External	n/a

reference	
Information source Output: Methodology for identifying salt-affected areas	
Description	Methodology based on spectral indices derived from remote sensing and combined with GIS technology for identifying salt-affected or potentially salt-affected areas, using information derived from the soil maps for their validation.
Dataset(s)	
Geographic scope	Pilot study areas in Navarra and Aragón (Spain)
Data provider	Government of Navarra, Tracasa, Government of Aragón, CITA
Thematic scope	Soil, agriculture
Scale, resolution	n/a
Delivery	n/a
Documentation	n/a
External reference	n/a

B.6 MARS project

Yield forecasting within the MARS project

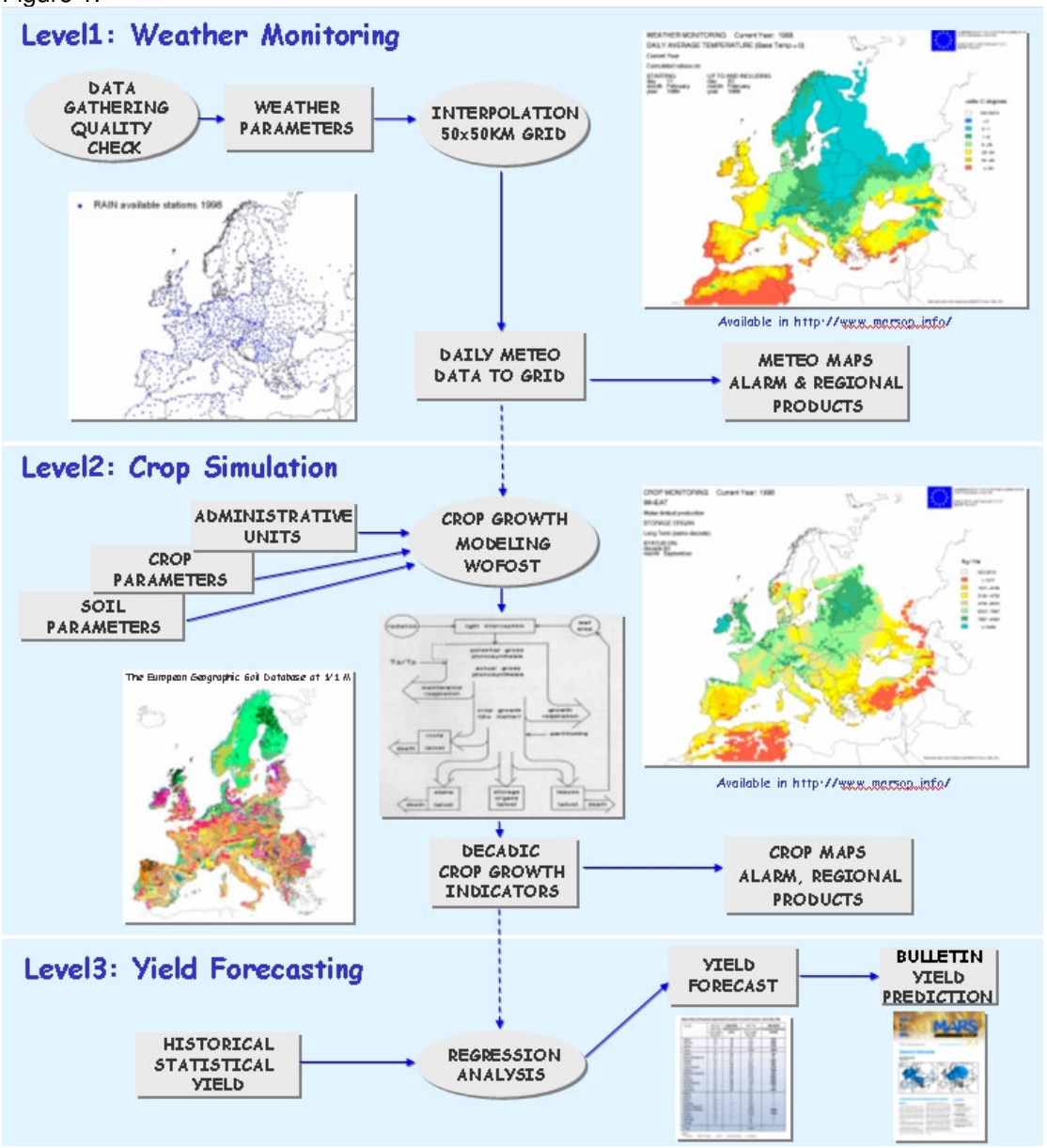
For the implementation of the Common Agricultural Policy, the European Commission needs timely information on the agricultural production to be expected in the current season. This is a main concern of the MARS-project (Monitoring Agricultural ResourceS). A Crop Yield Forecasting System (MCYFS) has been developed. It is managed by the Joint Research Centre (JRC) of the European Union (EU) in Ispra, Italy. The aim of the MARS crop yield forecasting system is to provide accurate and timely crop yield forecasts and crop production biomass for the union territory and other strategic areas of the world. The rationale behind the crop forecasts at EU level is based on the lack of timely information to take rapid decision on CAP instruments during the year.
A Crop Forecasting System has been developed and operationally run since 1992 in order to provide timely crop production forecasts at European level. This system is able to monitor crop vegetation growth (cereal, oil seed crops, protein crops, sugar beet, potatoes, pastures, rice) and include the short-term effects of meteorological events on crop productions and to provide yearly yield forecasts on European crops. This system is made by remote sensing and meteorological observations, agro-meteorological modelling (Crop Growth Monitoring System (CGMS), MARS Model Library) and statistical analysis tools.

We focus in this use-case on crop growth monitoring system (CGMS) as it is the system where soil data are used.

The Crop Growth Monitoring System developed by MARS Project provides the European Commission (DG Agriculture) with objective, timely and quantitative yield forecasts at regional and national scale. CGMS monitors crops development in Europe, driven by meteorological conditions modified by soil characteristics and crop parameters. This mechanistic approach describes crop cycle (i.e. biomass, storage organ …) in combination with phenological development from sowing to maturity on a daily time scale. The main characteristic of CGMS lies in its spatialisation component, integrating interpolated meteorological data, soils and crops parameters, through elementary mapping units used for simulation in the crop model. The core of the system is based on 2 deterministic crop models, WOFOST and LINGRA. GIS tools are used to prepare data and to produce results maps. Input and output are stored in a RDBMS. Statistical procedures are used to forecast quantitative crops yield.

In summary, CGMS consists of three main parts (figure 1):
1. Interpolation of meteorological data to a square grid
2. Simulation of the crop growth
3. Statistical evaluation of the results

Figure 1.


Level1: Weather Monitoring
DATA GATHERING QUALITY CHECK
WEATHER PARAMETERS
INTERPOLATION 50x50KM GRID
RAIN available stations 1998
Available in http://www.marsop.info/
DAILY METEO DATA TO GRID
METEO MAPS ALARM & REGIONAL PRODUCTS
Level2: Crop Simulation
ADMINISTRATIVE UNITS
CROP PARAMETERS
SOIL PARAMETERS
CROP GROWTH MODELING WOFOST
The European Geographic Soil Database at 1/1 M
Available in http://www.marsop.info/
DECADIC CROP GROWTH INDICATORS
CROP MAPS ALARM, REGIONAL PRODUCTS
Level3: Yield Forecasting
HISTORICAL STATISTICAL YIELD
REGRESSION ANALYSIS
YIELD FORECAST
BULLETIN YIELD PREDICTION
MARS

Use Case Description	
Name	Crop Growth Monitoring System
Priority	high
Description	CGMS provides the European Commission (DG Agriculture) with objective, timely and quantitative yield forecasts at regional and national scale.
Legal foundation(s)	no legal base but is part of activities of the DG Agriculture around the CAP
Pre-condition	
Flow of Events - Basic Path	
Step 1	Gathering of meteorological data, quality control of the data and interpolation on a 50 km by 50 km grid
Step 2	determination of the parameters of the crop model: soils, crops and definition of simulation units
Step 3	crop simulation using data from step 1 and 2 with the crop model (three crop models are used following the crops)
Step 4	analysis of historical statistical yield data and correction of the indicators of crop simulation to define yield forecast
Step 5	realisation of maps and bulletins for end-users
Post-condition	
Actors	
End-users	• DG Agriculture • + any third parties for some data and tools that are freely downloadable
Information provider(s)	Meteorology authorities, ESBN for the soil DB
Information processors(s)/Brokers	JRC
Information Source Input	
Description	• meteorological daily data: rainfall, temperature, global radiation, wind speed, etc. • Soil information issued from SGDBE • crop data: location at regional level, sowing date, harvest date, crop yield at regional level • administrative units
Thematic scope	Soil, Agricultural Facilities, administrative units
Base datasets	• Soil map: The soil data are used in the system in two ways: - estimation of soil parameters for the crop model: for each STU of SGDBE there is estimation of depth of the soil, water retention at saturation, field capacity and wilting point using PTF. This needs the derived soil profile with its FAO soil name, parent material, depth to textural change, depth of an obstacle to roots, agricultural limitations, topsoil and subsoil texture. - definition of simulation units: this needs: (1) soil association area and soil association (with list of STUs and percentage of area) to overlay with administrative units and meteorological grid (2) derived soil profile with its FAO soil name and agricultural limitations, depth of an obstacle to roots, depth to impermeable layer, texture, water regime to define crop suitability. If the unit is estimated to be unsuitable for a given crop, then the unit is not used for crop simulation.

	• meteorological data: used as input for crop simulation and to determine climate suitability for crops • administrative units • statistical data on yield • grid for interpolation of meteorological data • crop parameters and crop calendar obtained through expert knowledge
Data provider	Soil: ESBN Yield: Eurostat Meteo: Meteorological authorities
Scale, resolution	Europe
Documentation	• web site • reports
External reference	•
Information Source Output	
Description	meteorological maps for alarm crop maps yield estimates (maps and tables: publication of a periodic bulletin)
Thematic scope	Agricultural Facilities Climate
Base dataset(s)	• interpolated daily meteorological data • crop yield estimate • several outputs from the model
Data provider(s)	JRC
Scale, resolution	Europe
Documentation	web site of Mars project bulletins reports
External reference	

B.7 Restrictions for agriculture use based on mineral, the N-, and P-saturation in the soil and (shallow) ground water

For agricultural use of land it is important to know, based on soil classification and soil analysis, what limitations do exist based on the leaching of N and P into the ground water. In the WFD there are thresholds indicating the maximum values allowed. Secondly it is important to know the vulnerability for contamination of the ground water by minerals (N,P) due to agricultural practices in relation to the soil present at that location.

The questions in this use case are →

- What is the vulnerability of leaching of NP due to the values for the relevant properties in the soil?
- What is the maximum level for fertilizer application used by the farmers?

The outcome of this use case is usually a map based on the results of the calculation of the mineral usage, saturation and loss (Model). The model uses in NL are ANIMO and Waterpas

- ANIMO → Prediction of Nitrogen and Phosphorus leaching to groundwater and surface waters [http://www.animo.wur.nl/Documents/Report%20983.pdf]
- Waterpas → Effects of water management on agriculture [http://meetings.copernicus.org/www.cosis.net/abstracts/EGU2007/02561/EGU2007-J-02561.pdf]

The map shows where restriction zones and limitations are present. This is used for policy, monitoring and enforcing of nature conservation areas and water protection zones

To illustrate the specific situation we describe the following on the local scale.

NP application is dispersed on the soil (the fertilising process of the farmer); part of the minerals are tied to organic matter, part is tied to soil minerals, part is taken up by the crop during the growing season. Not all minerals are consumed by the crop, the loss is accumulates in the soil. This accumulation continues until the capacity of the soil is reached. The excess is leached to the deeper out of reach of the roots of the crop and is lost into deeper ground water or is drained via the surface water system. The Nitrogen can also be denitrificated which is vaporized in to the air (NO2). In the WFD the threshold for Nitrate is 25 milligrams/ liter (in the ground water) at a depth of 2 meter.

Note: similar use case can be defined for other applicants (crop protection chemicals)
Leaching is determined for nitrate by the pF,the ground water table and the amount of carbon in the soil. For Fosphate by the pH (most important), Fe, Al. (Ferrro-alluminium complex) **Error! Objects cannot be created from editing field codes.**

Use Case Description	
Name	Restrictions for agriculture use based on the N- and P-saturation in the soil and (shallow) ground water
Priority	medium
Description	For agricultural use of land it is important to know, based on soil classification and soil analysis, what limitations do exist based on the leaching of N and P into the ground water. In the WFD there are thresholds indicating the maximum values allowed. Secondly it is important to know the vulnerability for contamination of the ground water by minerals (N,P) due to agricultural practices in relation to the soil present at that location *Note: similar use case can be defined for other applicants (crop protection chemicals)*
Legal foundation(s)	WFD, Nature2000, National regulations for Ground water protection zones for drinking water.
Pre-condition	Measurements and observations on soil and ground and surface water (monitoring programme for the WFD)

Use Case Description	
Flow of Events - Basic Path	
Step 1	Determine Soil type and absorption capacity for minerals (analysis results based on soil properties)
Step 2	Compute the mineral usage, saturation and loss (Model)
Step 3	Represent the model results → usual in a map
Step 4 (potential)	Use results in EU/National protect areas for Nature (compare monitoring programme)
Step 5	Use results for licensing agricultural use and enforcing legal regulations in NP use.(e.g. in NL the Sand, Peat and Clay map)
Post-condition	Improved soil and ground water quality and sustainable use of agricultural resources
Actors	
End-users	• Authorities → EU-level --. JRC; national Min of Agriculture, Water, Environment; regional water authorities • Farmers • Nature conservation bodies
Information provider(s)	Public, Soil Bureau, Water Authorities
Information processors(s)/Brokers	Private and public→ data collection companies, Laboratories, consultancy companies
Information Source Input <list what the input of the use case will be. If more information sources are produced list each source separately>	
Description	• Soil information on Soiltype, Mineral composition, pH Organic Matter, Groundwater levels → as an example see annex "table 6" for the detailed soil input data for the Nutrient model ANIMO • Fertilizer practices (historic and current)* • Land cover • Agricultural parcels and practice
Thematic scope	Soil, Agricultural Facilities, geology, hydrology, land cover
Base datasets	• Soil map • ground water level (classes) • Soil and water (ground and surface) sample analysis • Water monitoring networks (WFD)
Data provider	Soil bureaus Water authorities Environmental agencies WFD monitoring authorities
Scale, resolution	Regional (10.000 and up)
Documentation	• WFD (water quality only) • Denitrification model reports
External reference	• Dutch reference for producing the Sand, Clay Peat map (LNV-loket)
Information Source Output <list what the output of the use case will be. If more information sources are needed list each source separately>	
Description	Output will represent , usually in a map where restriction zones and limitations are present
Thematic scope	hydrology (Soil, Agricultural Facilities)
Base dataset(s)	• Water protection zones with limitations/restrictions NP application • Dutch reference for producing the Sand, Clay Peat map (alterra)

Use Case Description	
Data provider(s)	Ministries, regional and local government
Scale, resolution	Regional (10.000 and up)
Documentation	References available in the member states (NL: Sand, Clay, Peat map report, and regional water management plans) and the NL regulation on mineral use in agriculture (meststoffenwet)
External reference	(LNV-loket)

*) The danger of leaching is very much related to historic land use (farmers spreading too much fertilizer/manure) and soil type characteristics. Consequences of historic land use show in the results of the farmer samples (used for fertilizing advices). These elements can not available in central databases. So you are fully dependent on:

1. Statistical data on the use of fertilizers/manure in a region.
2. soil data (soil map with underlying soil type characteristics)
3. results from regional water monitoring systems showing excesses in the concentrations of NP

Table 6 The input file SOIL.INP: soil chemical and soil physical data

Description of variable	Unit	Range	R	DT	Mnemonic	
Label for specification of geometry data	-	**>profil:**	*	C8	LABEL	
Number of soil horizons for which data are provided (should correspond with file SWATRE.UNF or WATBAL.UNF)	-	[1 ... MANH]	*	I	NUHO	
Thickness of the virtual reservoir where fertilizer additions are leached from proportional to the cumulative precipitation since the fertilization event	m	[0.0 ... 0.2]	*	R	HETOP	
Thickness of compartment on top of the soil surface (in case of ponding)	m	[0.0 ... 10.0]	-	R	HE(0)	
Fraction of surface runoff passing the surface reservoir and flowing either to surface waters or to the first soil layer	-	[0.0 ... 1.0]	*	R	LEFRRV	
Fraction of runoff passed through the surface reservoir that passes the first soil layer	-	[0.0 ... 1.0]	-	R	LEFRSO	
Depth of the initial root zone	m	[0.0 ...]	*	R	RODP	
Label for specification of temperature data	-	**>tempar:**	*	C8	LABEL	**This label only if soil temperatures are not provided by the result of the hydrological model**
Frequency of annual temperature wave	rad d^{-1}	[0.015 ... 0.02]	*	R	FQTE	
Thermal diffusivity	m^2 d^{-1}	[0.01 ... 0.1]	-	R	TESMCF	
Amplitude of annual sine wave	^oC	[0.0 ... 30.0]	*	R	APTE	
Average annual temperature at soil surface	^oC	[-30.0 ... 30.0]	-	R	AVTE	
Phase shift of temperature wave	rad	[0.0 ... 6.28]	-	R	PHSH	
Label for first specification of diffusion and soil physical data	-	**>sophy1:**	*	C8	LABEL	
Array with constant in oxygen diffusion relation per horizon in air filled part of the soil according to: $\frac{D_{soil}}{D_{air}} = p_1\,(gas\ fraction)^{p_2}$	-	[0.0 ... 10.0]	*	R	PMDF1HN, PMDF2HN (NUHO)	
Array with saturated conductivity per horizon	m d^{-1}	[0.0 ... 10.0]	*	R	CDSAHN (NUHO)	
Array with dry bulk density per horizon	kg m^{-3}	[0.001 ... 2700.0]	*	R	RHBDHO (NUHO)	
Array with C/N-ratio per horizon	-	[5.0 ... 60.0]	*	R	CNRATIOHO (NUHO)	
Array with temp. response coefficient for organic transformations and nitrification per horizon	J mol^{-1}	[0.0 ... 100000.0]	*	R	ACRDTEHO (NUHO)	
Array with temp. response coefficient for transformation of dissolved organic matter (Arrhenius) per horizon	J mol^{-1}	[0.0 ... 100000.0]	-	R	ACRDTEDISHO (NUHO)	
Reduction factor for decomposition rate of soil organic matter (humus) in subsoil	-	[0.0 ... 1.0]	*	R	RDFADCHU	
Label for second specification of soil physical data	-	**>sophy2:**	*	C8	LABEL	**This label only if IWA=1**
Switch to select distribution of evapotranspiration flux EVROSE=0: uniform root extraction EVROSE=1: root extraction decreases linear with depth	-	[0 ... 1]	*	I	EVROSE	
Switch to select kind of input of soil physical variables NUPF-SCPF OPTPFHN=0: values are provided for two zones (root zone and subsoil) OPTPFHN=1: values are provided for each soil horizon (only relevant for regional SIMGRO applications)	-	[0 ... 1]	*	I	OPTPFHN	

Table 6 The input file SOIL.INP: soil chemical and soil physical data

Description of variable	Unit	Range	R	DT	Mnemonic	
If OPTPFHN = 0: K = 2 If OPTPFHN = 1: K = NUHO						
Array with number of data-pairs the moisture retention curve is described with of horizon HN for every K	-	[3 ... 100]	*	I	NUPF(K)	
Array with volume moisture fractions of horizon HN for every NUPF(K)	$m^3\ m^{-3}$	[0.0 ... 1.0]	*	R	MOFRPF (NUPF(K))	
Array with suction values of pF-curve of horizon HN for every NUPF(K)	cm	[0.0 ... 1.0E+7]	*	R	SCPF(NUPF(K))	
Capillary height: distance between root zone and groundwater level if capillary rise flux equals 0.1 mm d^{-1} under steady state conditions	m	[0.1 ... 3.0]	*	R	HECZ	**Only if OPTPFHN = 1**
Label for specification of soil chemical data	-	**>sochem:**	*	C8	LABEL	
Array with pH-H_2O per horizon	-	[3.0 ... 9.0]	*	R	PHHO(NUHO)	
Array with NH_4-N sorption coefficient per horizon	$m^3\ kg^{-1}$	[0.0 ... 0.05]	*	R	SOCFNHHO (NUHO)	
Label for specification of soil chemical data for phosphorus	-	**>soalfe:**	*	C8	LABEL	
Switch for type of input concerning Al and Fe input OTPALFE = 0 no values for Al and Fe are given in Soil.Inp file (Values should be specified in the file Chempar.inp) (**Not optional)** OTPALFE = 1 Sum of Al and Fe per horizon is specified OTPALFE = 2 Both Al and Fe per horizon are specified	-	[0 ... 2]	*	I	OPTALFE	**This label only if IPO=1**
Array with Al+Fe-content of horizons 1-NUHO	$mmol\ kg^{-1}$	[5.0 ... 1000.0]	-	R	ALFEHO (NUHO)	**Only if OPTALFE=1**
Array with Al-content of horizons 1-NUHO	$mmol\ kg^{-1}$	[5.0 ... 500.0]	-	R	ALHO (NUHO)	**Only if OPTALFE=2**
Array with Fe-content of horizons 1-NUHO	$mmol\ kg^{-1}$	[5.0 ... 500.0]	-	R	FEHO(NUHO)	
Label for specification of macro pore data **(Not operational in ANIMO version 4.0!)**	-	**>MPdscf:**	*	C8	LABEL	**This label only if ioptMP=1**
Diffusion coefficient for NH_4-N	$m^2\ d^{-1}$	[0.0 ... 0.1]	*	R	DSCFNH	
Diffusion coefficient for NO_3-N	$m^2\ d^{-1}$	[0.0 ... 0.1]	-	R	DSCFNI	
Diffusion coefficient for dissolved organic matter	$m^2\ d^{-1}$	[0.0 ... 0.1]	-	R	DSCFDIOR	
Diffusion coefficient for PO_4-P	$m^2\ d^{-1}$	[0.0 ... 0.1]	-	R	DSCFPO	**Only if IPO=1**
Label for specification of sandy soil	-	**>nisand:**	*	C8	LABEL	
Array with switch for indicator of sand per horizon 0: no sandy soil horizon 1: sandy soil horizon Use this label if distinction has to be made between sandy and not sandy soils concerning critical value of the moisture response of denitrification. See label '>sonic2:' in MATERIAL.INP. Only to be used in the framework of a STONE model application.	-	[0 ... 1]	*	I	Flsand(NUHO)	**This label only if ioptAE=1**

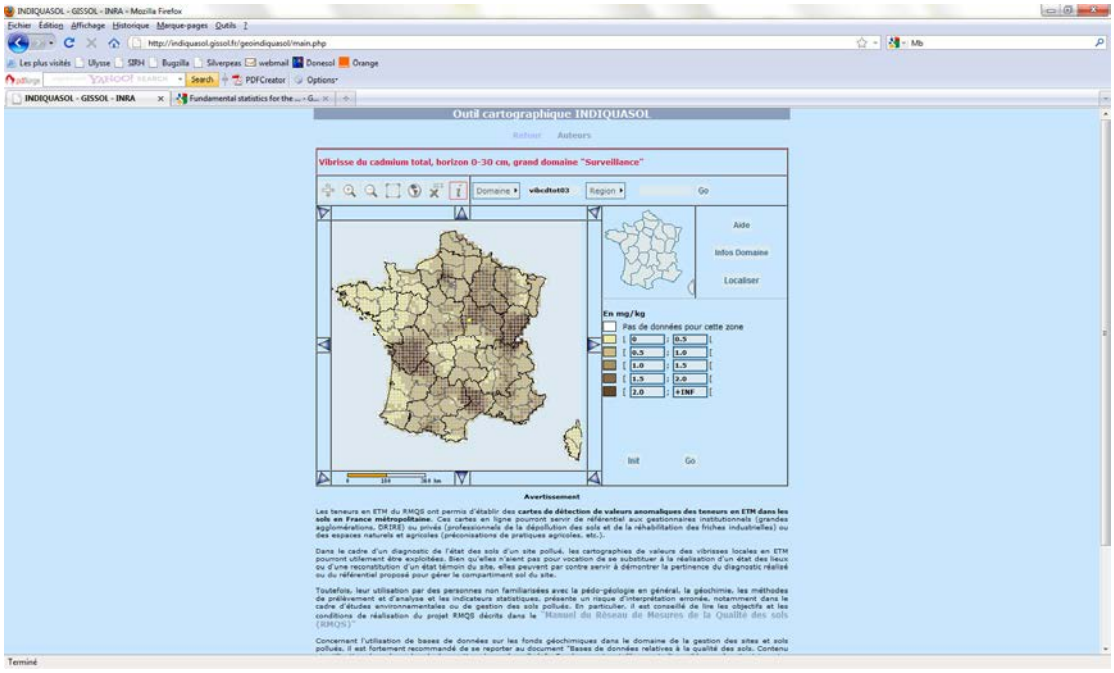
B.8 Calculation threshold trace elements

Estimation of regional trace elements threshold for anomalous values detection in France

To determine if a site is polluted or not with trace elements, it is needed to compare the analytical results obtained on samples from the site to the background values of trace elements in the region. Trace elements naturally vary following the soil type and the parent material.

In France, the ministry of environment is in charge of polluted sites. It asks Inra to calculate threshold values using the data from the French soil monitoring network. The threshold values are estimated for topsoil (0-30 cm) and for subsoil (30-50 cm) on a 16 km by 16 km grid for the following trace elements: Cd total + extractible, Co total, Cr total, Cu total + extractible, Mo total, Ni total + extractible, Pb total + extractible, Th total, Zn total + extractible. For each point of the grid, the estimation is based on the measured values of the 10 neighbouring points within a distance of 50 km for topsoil and subsoil respectively, and the calculation of the third quartile + 3x(interquartile range).

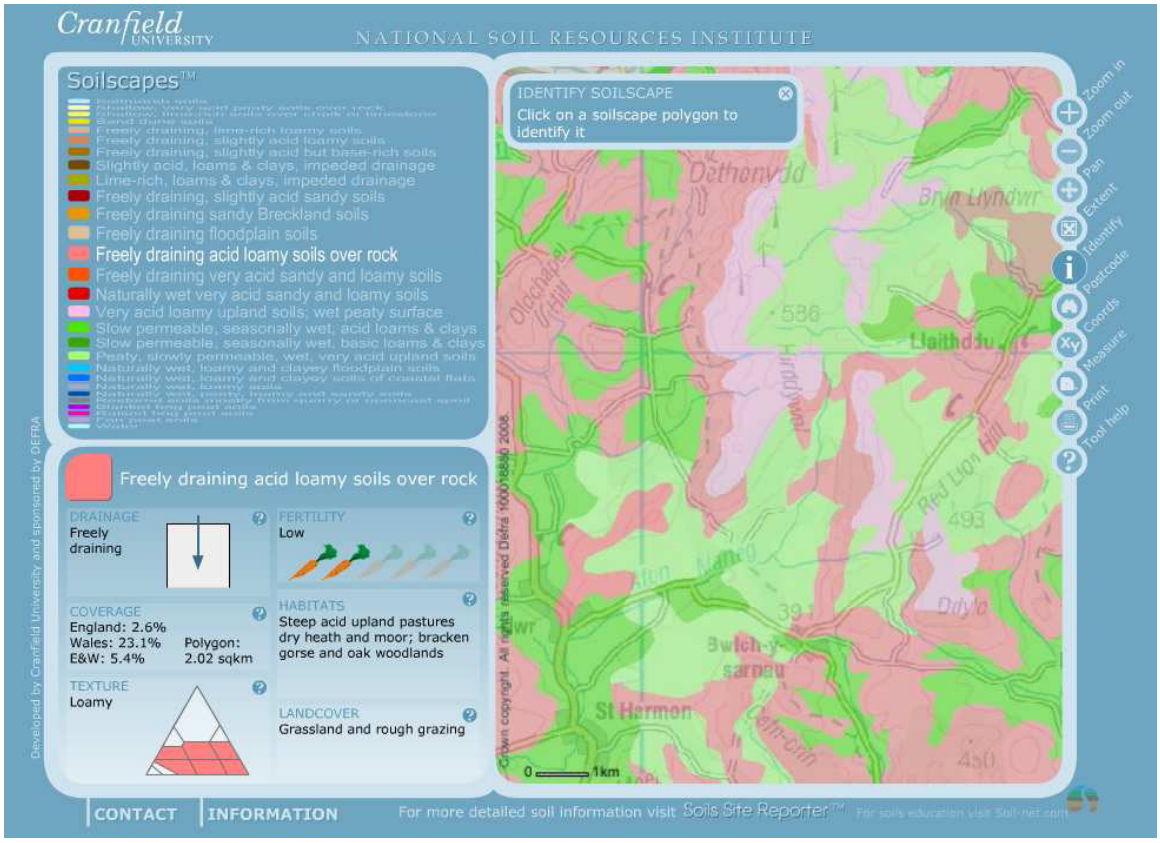
The figure below shows an example from the web site giving the Cd total threshold for 0-30 cm.



Use Case Description	
Name	regional trace elements threshold for anomalous values detection
Priority	high
Description	The aim is to furnish to public, values of reference at regional level for trace elements in topsoil and subsoil
Legal foundation(s)	no legal base but is part of activities around polluted sites legislation
Pre-condition	
Flow of Events - Basic Path	
Step 1	Determining for each trace elements and for topsoil and subsoil respectively, the list of 10 neighbouring points within 50 km having analytical values for each point of the grid.
Step 2	calculation of statistical data (third quartile + 3x(interquartile range)) at each point of the grid. No calculation is made if there is less than 10 points available.
Step 3	
Step 4	
Step 5	
Post-condition	
Actors	
End-users	• Public authorities • societies dealing with polluted sites • general public
Information provider(s)	GIS Sol (Inra is in charge of collecting and storing the data for the GIS Sol)
Information processors(s)/Brokers	Inra
Information Source Input	
Description	• soil monitoring network RMQS
Thematic scope	Soil
Base datasets	• soil monitoring network RMQS DB: - soil profile - observation location - for topsoil layer and subsoil layer the analytical value for each trace element.
Data provider	Inra
Scale, resolution	France, 16 km x 16 km
Documentation	• RMQS manual • article on the methodology
External reference	•
Information Source Output	
Description	threshold value for trace element per grid cell for topsoil and subsoil
Thematic scope	soil
Base dataset(s)	• Indiquasol
Data provider(s)	Inra
Scale, resolution	France, 16 km x 16 km
Documentation	web site
External reference	

B.9 Use of Soil Scape Viewer

The **Soilscapes Viewer** (see figure below) allows users to view and map the soils of England and Wales, searching by U.K. postcode or co-ordinates to see the general conditions at any point. An interactive legend allows users to click on a feature represented in the map and learn more about that soil type including drainage, texture, land cover, habitats, and fertility.



Soilscapes is a 1:250,000 scale, simplified soils dataset covering England and Wales. It was created from the far more detailed National Soil Map (NATMAP Vector) held by NSRI at Cranfield University, with the purpose of communicating effectively a general understanding of the variations which occur between soil types, and how soils affect the environment and landscape of the two countries.

Soilscapes Viewer is a simple web-application that gives web-access to the Soilscapes data The Soilscapes dataset is also available separately to lease as one of the NSRI soil data products. See also: http://www.landis.org.uk/services/soilscapes.cfm.

The web map displays the soil characteristics for the “soil type” (one of only 27) at the specified location (soil texture, drainage status, soil fertility, commonly associated habitat and land cover) and a statistical presentation how common the soils at the location are when compared to the national stock of soils of England and Wales.Tools are provided to allow the user to navigate around the map, to change the scale of view, to pan the view, to query the information at a given specified point and finally to produce printed output.

Soilscapes is not intended as a means for supporting detailed assessments, such as land planning applications or site investigations. For such applications, Cranfield has a parallel service termed Soils Site Reporter (*http://www.landis.org.uk/services/sitereporter.cfm*) that provides a comprehensive

report of all the soils data held by NSRI for specific locations, and it is this report that is designed for use in support of more localised interests.

Use Case Description	
Name	*Soilscapes Viewer*
Priority	*Low*
Description	*The WebMapping tool allows non-expert users to access simplified soil's information*
Legal foundation(s)	*none*
Pre-condition	*The thematic information and educational material are available.*
Flow of Events - Basic Path	
Step 1	*The user access to the webpage.*
Step 2	*The user accepts the Cranfield's terms and conditions.*
Step 3	*The user selects an area of interest by zooming or by selecting a postcode.*
Step 4	*The user identifies one of the 27 Soilscapes units on a specified location.*
Post-condition	*The system provides information about drainage, fertility, texture, etc. for the specified location*
Actors	
End-users	*General public*
Information provider(s)	*NSRI Cranfield University*
Information processors(s)/Brokers	*None (automatic interpretation of database)*
Information Source Output	
Description	*Web based soil map and information*
Thematic scope	*Soil characteristics*
Base datasets	*Interpreted map of the Soilscapes dataset*
Data provider	*NSRI Cranfield University*
Scale, resolution	*Maps derived from Soilscapes dataset at 1:250,000*
Documentation	*on website* http://www.landis.org.uk/services/soilscapes.cfm
External reference	*See web site*
Information Source Input	
Description	*In essence, there is only one dataset that serves as input to the Soilscapes Viewer: the Soilscapes dataset*
Thematic scope	*Soil (generalized data)*
Base dataset(s)	*Soilscapes dataset at 1:250,000*
Data provider(s)	*NSRI Cranfield University*
Scale, resolution	*Scale is 1:250,000*

Use Case Description	
Documentation	*on website* http://www.landis.org.uk/services/soilscapes.cfm
External reference	*See web site*

B.10 Establishment Less Favoured Areas (France)

Test of biophysical criteria for determining Less Favoured Areas in France

The aid to farmers in Less Favoured Areas (LFA) provides a mechanism for maintaining the countryside in areas where agricultural production or activity is more difficult because of natural handicaps (e.g. difficult climatic conditions, steep slopes, or low soil productivity). Due to the handicap to farming in these areas, there is a significant risk of agricultural land abandonment and thus a possibility of loss of biodiversity, desertification, forest fires and the loss of highly valuable rural landscape. To mitigate these risks, the Less Favoured Areas (LFA) help maintaining appropriate farming systems for preserving landscapes and habitats ranging from wetlands to dry meadows and mountain pastures. In many areas, this is also an important part of the cultural heritage and of the overall attractiveness of rural areas.
Following a report of the European Court of Auditors (in 2003) challenging the LFA scheme, the Commission departments launched the LFA review exercise. Meanwhile, a panel of soil, climate and land evaluation experts, co-ordinated by the Joint Research Centre, Institute for Environment and Sustainability of Ispra, was tasked to elaborate a scientific approach which could support the delimitation of agricultural areas with natural handicaps.
The expert panel identified a number of soil, terrain and climate biophysical criteria indicating, at a certain threshold value, severe limitations for standard European agriculture. The suggested criteria went through a wide ranging consultation (LFA expert group of the representatives of European Research Institutes and of the National Authorities, technical bilateral meetings between the Commission departments and the Member States) and were presented in a Communication [COM(2009)161: 'Towards a better targeting of the aid to farmers in areas with natural handicaps'] in April 2009. In order to provide a solid basis for elaborating the required legislative proposal and to fully involve Member States in the delimitation process, the Communication asks Member States to simulate the application, on their territory, with their data, of the biophysical criteria listed in the Communication and to produce maps of the areas that would result under such simulations.

In France, the test of the biophysical criteria listed in the Communication was undertaken by Inra through the request of the French ministry of agriculture. This test was realized on 6 “Departement” where a soil data base at a scale of 1:250,000 was available and where there are handicaps to agriculture due to soil conditions.

Use Case Description	
Name	Test of biophysical criteria for determining Less Favoured Areas in France
Priority	high
Description	The aim is to test the biophysical criteria proposed by the Commission, especially feasibility of the zoning considering available data in France
Legal foundation(s)	revision of the LFA zoning
Pre-condition	
Flow of Events - Basic Path	
Step 1	Calculation of the different criteria for each STU (derived soil profile). The criteria are: - drainage - texture and stoniness: stoniness, organic soils, heavy clay soils, sandy soils, vertic soils - rooting depth - chemical properties: salinity, sodicity, gypsum The table 1 below details the attributes of the soil DB used for estimating the different criteria
Step 2	Overlay of the SMU (soil association) with the communes
Step 3	calculation of area of each STU within the commune using the list of STU within a SMU and its percentage of area
Step 4	calculation of the area of the communes constrained by each criteria
Step 5	
Post-condition	
Actors	
End-users	• Ministry of agriculture • European Commission
Information provider(s)	GIS Sol (Inra is in charge of collecting and storing the data for the GIS Sol)
Information processors(s)/Brokers	Inra
Information Source Input	
Description	• soil survey data base at the “Departement” level
Thematic scope	Soil
Base datasets	• Soil survey DB (see table 1): - derived soil profile (STU) + attributes - derived soil horizons + attributes - Soil association (SMU + list of STUs and percentage of area)
Data provider	Inra
Scale, resolution	1:250 000
Documentation	• Donesol dictionary
External reference	•
Information Source Output	
Description	zoning of communes having a certain area constrained for each criteria
Thematic scope	soil
Base dataset(s)	list of communes with the area constrained for each criteria + maps
Data provider(s)	Inra
Scale, resolution	communes level
Documentation	
External reference	

Table 1: list of soil criteria proposed by the Commission and list of attributes used in the Soil DB to calculate them:

Criteria	**Definition**	**Attributes describing STU used for its estimation**
drainage	poorly drained soils (definition of Soil survey staff of USDA)	Soil name (Referentiel Pédologique, French classification) Depth to a gleyed horizon Depth to a pseudogley horizon Abundance of redoximorphic features (mottles, concretions) of horizons
sandy soils	average texture on rooting depth: unsorted, medium and coarse sand or coarse loamy sand (FAO definition)	clay, silt and sand content of horizons depth of appearance and thickness of horizons depth to and type of discontinuities
heavy clay soils	average texture on rooting depth: heavy clay (FAO definition)	clay, silt and sand content of horizons depth of appearance and thickness of horizons depth to and type of discontinuities
organic soils	more than 30% of OM on over 40 cm within 0-80 cm	Organic carbon or organic matter content of horizons depth of appearance and thickness of horizons
stoniness	more than 15% of coarse fragment within the topsoil	abundance of coarse fragment for the topsoil horizon
vertic soils	soils with vertic properties (WRB definition)	soil name name of horizons depth of appearance and thickness of horizons
rooting depth	< 30 cm	depth of appearance and thickness of horizons depth to and type of discontinuities
salinity	> 4 dS/m	soil name salinity of the horizon
sodicity	> 6 ESP	soil name sodicity of the horizon
gypsum content	> 15%	soil name

B.11 Contaminated Land Register Austria

Introduction
The Austrian contaminated land register (Verdachtsflächenkataster) contains information on historical landfills and sites of historical polluting activities. The register is made up from the information received from the local authorities. The process of registration is continuing. Registration of a received report only follows if the supplied information is considered sufficient. Inclusion in the register does not confirm actual risks, this should follow from investigations.

The information if a property is on the register is publicly available on basis of the land register identification number (Grundstücksabfrage online).

Purpose
Purpose of the system seems to be:

- Supporting the national policy on soil quality by building up insight into the extent of the problem of local soil pollution and
- to assist the planning and process of land rehabilitation by monitoring the progress and workload of investigations and remediations.
- To give information to the public, (i.e. land users and potential land buyers) to sites with possible risks

Current status
The report VERDACHTSFLÄCHENKATASTER UND ALTLASTENATLAS (Granzin, Valtl, Umweltbundesamt, Wien 2010) gives an overview of the current content of the register, geographical distribution, land use of sites, type of polluting activities and the main polluting substances and is available on *http://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0259.pdf*

The website mentions currently 58 000 registered sites, 2000 potential polluted sites to be investigated in more detail to decide on the need of remediation and 152 polluted sites yet known to be cleaned or protected, The state of remediation is: about 100 sites with remediation in progress and 100 sites with completed remediations.

The data in the system can be dived in:

- potential contaminated sites register (in land register)
- polluted sites atlas of Austria
- cleaning and protection measures
- surveys (after confirmed suspicion)

Comparable systems
Examples of comparable systems in the EU are

- the German inventory LABO/ ALA (Bund/Länder Arbeitsgemeinschaft Bodenschutz, Ständiger Ausschuss Altlasten) and
- the Netherlands LDB inventory (Landsdekkend Beeld Bodemverontreiniging / Bodemloket /Globis).

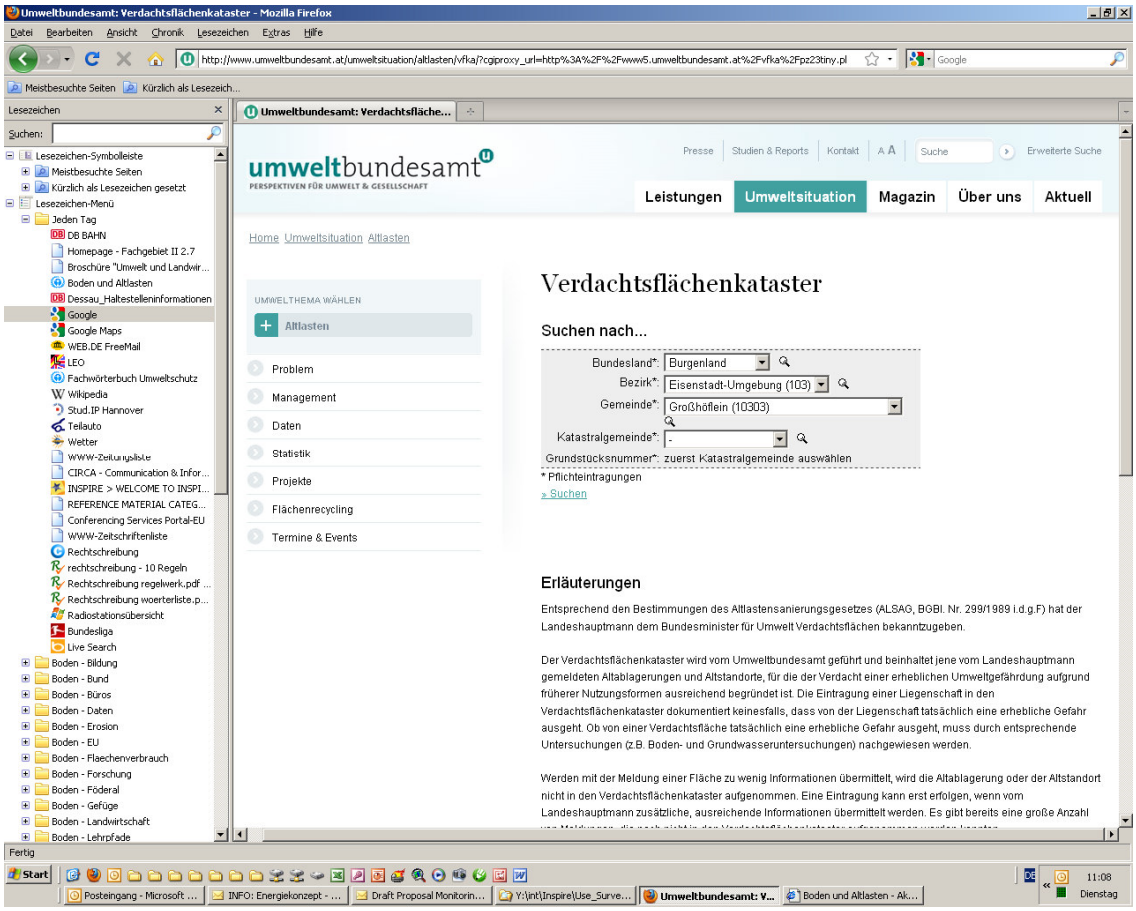
Overview of data in the system and examples of information screens

Potentially contaminated sites register (in land register)

= Overview of data on potentially contaminated sites in the system

- land register identification number
- description of the potential assumed deposits
  - → excavation material
  - → demolition waste
  - → garbage
  - → industrial waste
  - → hazardous waste
- description of the industrial and commercial activities
  - → 12 different branches
- description of the natural environment
- description of the vulnerable environment
  - → groundwater
  - → air
  - → surface water
  - → soil
- description of the administrative data (calendar date of adoption)
  - → classification in risk areas (four classes)

= example of information screen on potentially contaminated sites



= *Discussion:*
It is a point of discussion to have potentially polluted sites included in any EU inventory. When doing so a general guideline for comparability is essential. But as the polluting activities may differ from country to country this can be expected to be difficult. The inventory can be broad or narrow. As an example: in the Netherlands the choice was made for an extensive list of potentially polluted sites. After ongoing investigations many categories were skipped because for those categories there appeared to be very little sequence in soil investigations leading to the need of cleaning or protection.

The type of deposits seems to be a good indicator, but may also be part of a description of the polluting activities.
The description of the natural environment is probably related to ecological risks. In relation to human risks the current and planned land use is of more importance.

In the Netherlands a much more extensive list is used, consisting of several hundred branches of polluting activities (following European NACE-codes, but sometimes splitting up because of historical variations in the processes and consequentially the situation of pollution).

Surveys (after confirmed suspicion)

= Overview of data in the system:

a) first survey
- completed
- in progress

b) detailed survey
- completed
- in progress

= Discussion:
Dates of survey seem not to be included as well as final conclusions.
The tiered approach may help to prevent a large investigation expenditure on sites of less importance.
The quality standards of the investigations are important because of the high costs of cleaning. Is the investigation sufficient in relation to cleaning and protection measures (including sufficient data on the size of the polluted area, pollutants, pollutant levels and soil types) or only sufficient to know it is polluted or not.
This item coincides with the status of investigation in the draft 1 proposal on contaminated sites of the TGW Soil.

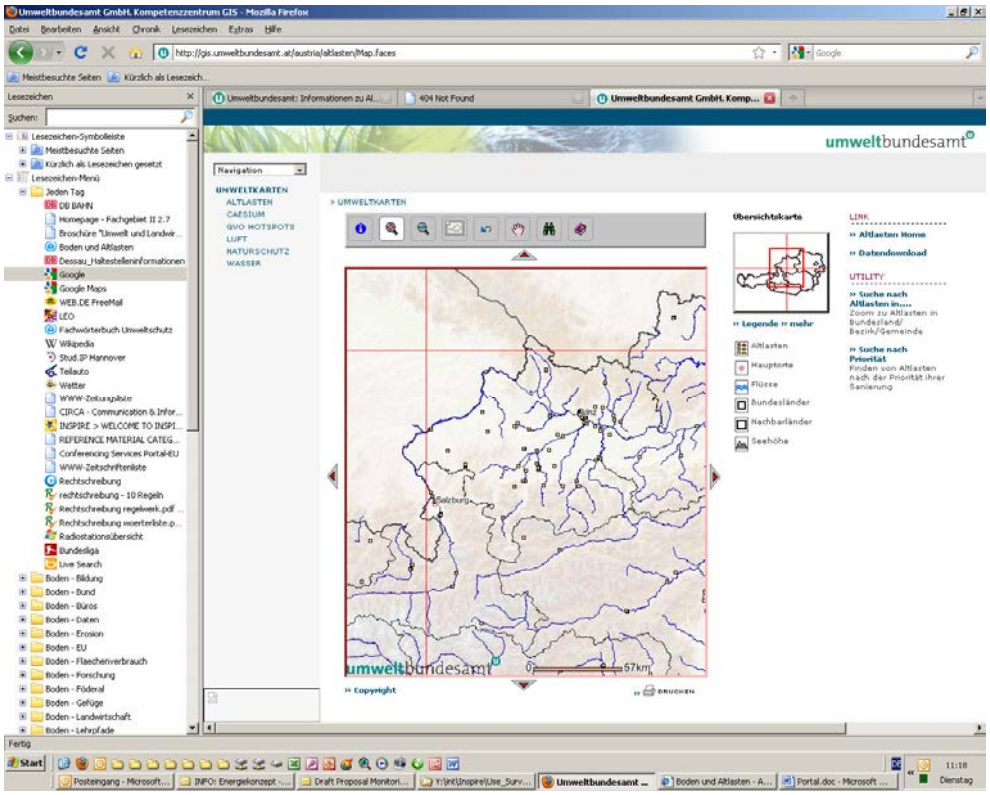
Polluted sites atlas - Austria

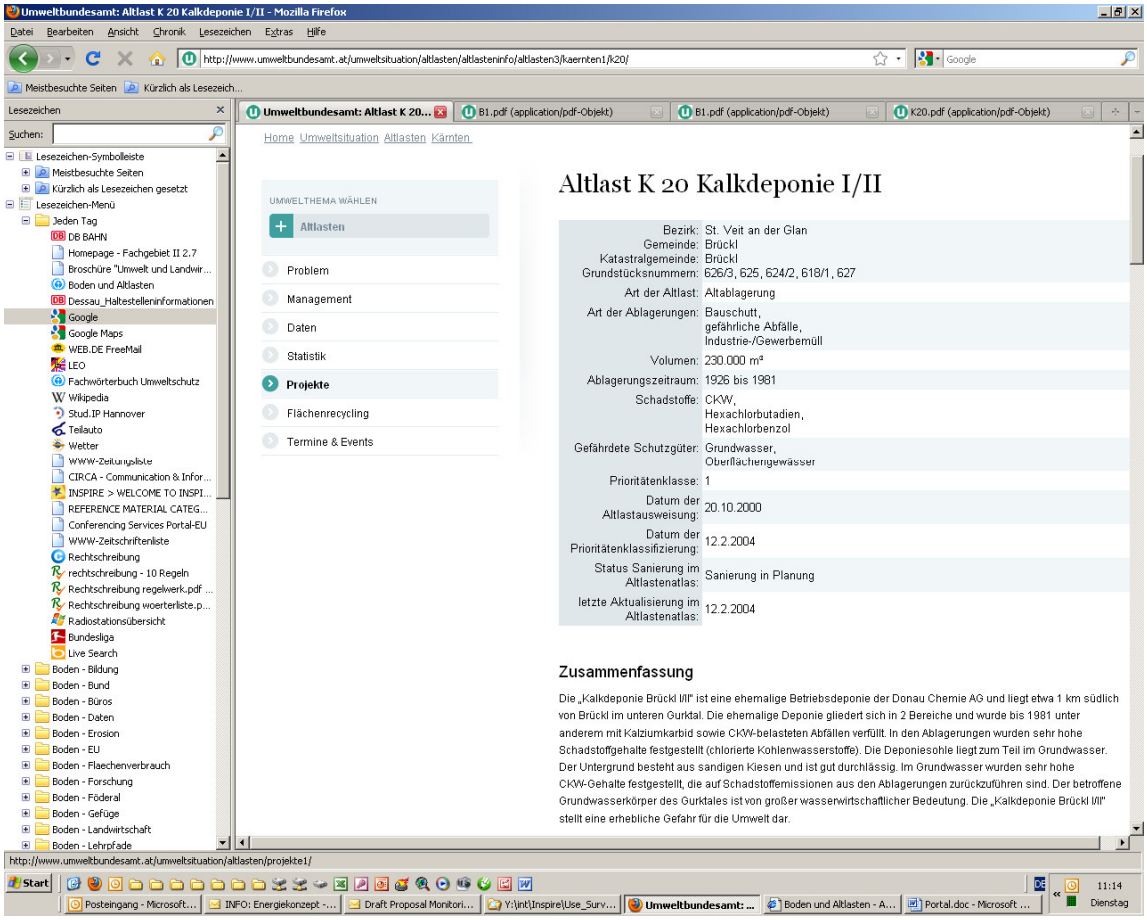
= Overview of data on polluted sites in the system
- name
- land register identification number
- kind of polluted site (“old deposit, old-site”)
- kind of deposits
  - → garbage
  - → urban repository
  - → commercial repository
- description of the industrial and commercial activities
- pollutants
  - → CKW
  - → petroleum
  - → heavy metals
  - → PAK
  - → other
  - → Phenol
  - → BTEX
  - → Cyanide

- current use
  - → industrial area
  - → brownfield
  - → repository
  - → agriculture
  - → housing zone
- calendar date (adoption in atlas)
- status of pollution management (classification in Austria)
- calendar date (status classification)

→ complete and detailed description (measurement data: soil-air, soil, groundwater) of the site an all kinds of relevant information can be added in an extra file for download; also a detailed site map and risk assessment

= examples of information screens on pollutes sites





= Discussion:
The kind of polluted site can be related to polluting activity and land use.
Status of investigation is not included, probably because sites are added only after formal decision or on the basis of a detailed investigation.
A longer list of pollutants should be expected.
Beside current land use also planned land use is of importance for the value of actions in relation to protection and cleaning. A classification of land use in relation to risks is recommended.

<u>*Cleaning and protection measures*</u>

= Overview of data on cleaning and protection measures in the system:

- cleaning planned
- protection planned

- cleaning in progress
- protection in progress

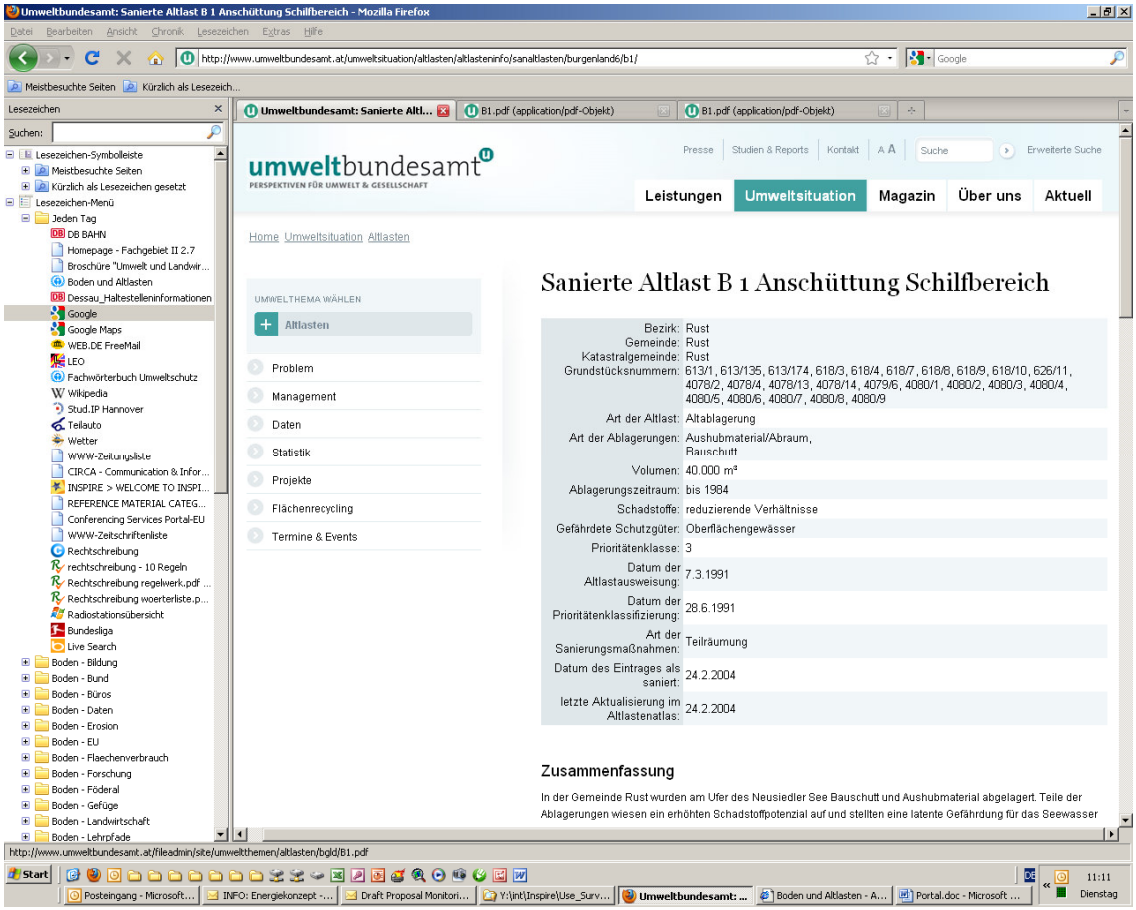
- cleaning completed
- protection completed

→ complete and detailed description of the site and all kinds of relevant information can be added in an extra file for download

= Discussion:
The addition planned dates should be more informative.

If protection measures ae taken (against risks or dispersion while leaving pollution largely on the site) it is important to know if and how the need of maintenance is covered and when cleaning it is important to know if the cleaning is complete (for a certain level of pollution and performed in both soil in the unsatured and satured zones).
This item coincides with the status of pollution management in the draft 1 proposal on contaminated sites of the TGW Soil.
From experience in the Netherlands it is recommended to add after the technical completion: a last step of organisatorial completion, going into the evaluation of the work (answering questions like: were the quality of cleaning and the plan for aftercare sufficient? is the plan for aftercare financially covered? and are the connected contracts arranged?)

= example of an information screen on cleaning and protection measures of a completed site



Use Case Description	
Name	Contaminated land register Austria
Priority	High
Description	System to provide information on historical landfills and sites of historical pollution, including potentially contaminated sites, surveys completed and in progress, confirmed pollutes sites, cleaning and protection measures. The full data structure is not available. The information if a property is on the list is public but does not confirm actual risks.
Legal foundation(s)	National regulations for property transfer of real estates.
Pre-condition	Measurements and observations on soil and ground and surface water.
Flow of Events - Basic Path	
Step 1	Record land register identification number
Step 2	Record potential historical contamination connected with these land register identification numbers
Step 3	Record soil surveys connected with these land register identification numbers
Step 4	Record cleaning and protection measures connected with these land register identification numbers.
Actors	
End-users	• National and local authorities, Ministry of the environment • Real estate brokers • Citizens that are selling or buying real estate
Information provider(s)	Local authorities
Information processors(s)	Ministry of the environment
Information Source Input <list what the outcome of the use case will be. If more information sources are produced list each source separately>	
Description	• Historical activities with potential pollution • Surveys, cleaning and protection measures • Confirmed polluted sites
Thematic scope	Soil contamination status
Base datasets	• reports received from local authorities • Soil maps • Soil and water (ground and surface) sample analysis
Data provider	Local authorities
Scale, resolution	Regional (50 m^2 and up)
Documentation	Report Verdachtsflächenkataster und Altlastenatlas (Granzin, Vatl, Umweltbundesamt Wien, 2010)
External reference	
Information Source Output <list what the input of the use case will be. If more information sources are needed list each source separately>	
Description	Atlas of polluted sites in Austria, Public information if a land register

Use Case Description	
	identification number is included in the register of historical pollution.
Thematic scope	Soil pollution status
Base dataset(s)	• Previous soil investigations • Historical activities • Cleaning and protection measures taken
Data provider(s)	Land register, ministry of the environment
Scale, resolution	Regional (50 m2 and up)
Documentation	See website
External reference	*http://www.umweltbundesamt.at/austria/altlasten*

B.12 Risk for drinking water wells by contamination

Soil and groundwater pollution may have many sources: industry, constructions, business areas, direct discharges in the soil, landfills, underground infrastructure like sewers, oil tanks, transport pipes, traffic, building activities, agricultural dispersion of manure, fertilizer and pesticides. The processes involved are calamities, intentional dispersion (pesticides, deicing salts), corrosion, wear, leakage, leaching and atmospheric deposition. For current activities soil protection measures like liquid proof floors, of process measures (closed systems) are or can be incorporated in permits for the activities. There is however a burden of historical soil contamination, consisting of diffuse polluted or contaminated areas and of more localized sites.

The Netherlands local authorities have made a joined effort to compose a nationwide inventory consisting of the description and mapping of all possibly polluted sites. Basis was a list of current and historical activities (UBI) with high risk of soil pollution. Archives and aerial photographs were used to localize the sites. The description includes references to type of activities, size of site, decisions made on investigations and management. Most municipalities collect this in a geographical soil information system. Generally there is a distinction in possible polluted sites (for which should be decided on the priority for investigation) and sites with ongoing actions. Since the baseline measurement in 2004 (of 425.000 sites) now about 40% of the sites is dealt with (after remediation or investigation only). Activities are ongoing on 20% of the sites and 40% is waiting for checks and investigations.

Any suspicion of soil pollution in a drinking water area should be reported to the ministerial environmental inspectorate (including calamities and crossing of threshold levels). After realization of the nationwide site inventory one of the checks for resulting risks of soil pollution was that of sites located in groundwater protection areas. These groundwater protection areas are established around drinking water extraction areas and based on the expected travel time of a mobile pollution from the surface to the drinking water extraction area (in 25, 50 and 100 years). It was found that 5,5% of the sites from the inventory were in groundwater protection areas. This may affect about half of the drinking water areas (79 of 194).

Not all sites involved are comparably relevant. Questions to be answered are about the chemical components involved (toxicity, mobility and amount), the proximity of to the drinking water well, the current state of the dispersion and the coincidence of more sites. The analyses lead to 2 drinking water areas with high risks, 36 with medium risks and 20 groundwater protection areas with high risks, and 15 with medium risks. Main polluting activities here were petrol service stations, dry cleaners and various industrial activities (metal works, wood conservation, building). The expected contaminating substances were checked in the database of chemical analysis of drinking water pumping stations. If 75% of the safe drinking water threshold level is crossed the EU Groundwater Directive demands measures to counteract the trend. In 14 such cases a connection could be made to pollution from petrol service stations and in 7 cases a connection to dry cleaners. This gave a point of departure for the counteracting measures (This is an early warning system, the wells were in danger but not yet unusable. Though the 75% of the threshold level was met not in all cases also the (100%) safe drinking water threshold level was crossed).

A decision should be made on the need of management, possibilities to counteract dispersion of pollution, or the closing of the drinking water well. This is the responsibility for the local authorities in cooperation with drinking water companies.

The relevance of the protection of drinking water is directly related to the protection of human- and ecological health.

RIVM-report 734301029 Bouwstenen Leiddraad Grondwaterbescherming (Components for a guidance document on groundwater protection) by S. Wuijts, J.F. Schijven, N.G.F.M van der Aa, H.H.J. Dik, C.W. Versluijs, H.J. van Wijnen (Bilthoven , The Netherlands 2007)

Use Case Description	
Name	Recognition of polluted sites as cause of pollution of drinking water wells
Priority	Medium
Description	Polluted sites are one of the threats to drinking water provision. When threshold levels in water from pumping stations is approached the GWD demands that measures are taken to counteract the trend. To provide for this the recognition of close by polluted sites gives a point of departure to act.
Legal foundation(s)	EU Directive on the protection of groundwater against pollution and detoriation (2006 118/EC), National regulations for Ground water protection zones for drinking water.
Pre-condition	Inventory of polluted sites and knowledge on the pollution profiles of those sites. Measurements on water from pumping water stations.
Flow of Events - Basic Path	
Step 1	Inventory and characterisation of polluting activities in past and present
Step 2	Locate sites where polluting activities took place
Step 3	Compare expected pollutants with found pollutants from drinking water wells to recognise adverse contribution of polluted sites on water quality
Step 4	If polluted sites are found with passing thresholds levels, consider possible countermeasures on the site and/or on the path from the site
Post-condition	Improved soil and ground water quality and protection of drinking water quality
Actors	
End-users	• Authorities → EU-level --. GWD; • National : Drinking water companies Min of Agriculture, Water, Environment; regional water authorities
Information provider(s)	Municipalities, provinces
Information processors(s)/Brokers	Private and public→ data collection companies, Laboratories, consultancy companies
Information Source Input <list what the outcome of the use case will be. If more information sources are produced list each source separately>	
Description	Early warning system connecting data of soil pollution with data of drinking water wells
Thematic scope	Protection of drinking water provision from soil pollution
Base datasets	• REWAB (composition of water from extraction wells) LDB Netherlands Inventory of polluted sites
Data provider	Provinces, municipalities, drinking water companies
Scale, resolution	Regional
Documentation	RIVM report 734301029/2007
External reference	
Information Source Output <list what the input of the use case will be. If more information sources are needed list each source separately>	
Description	Selection of drinking water well art risk from soil pollution
Thematic scope	Protection of drinking water provision from soil pollution
Base dataset(s)	• private
Data provider(s)	Provinces, municipalities, drinking water companies

Use Case Description	
Scale, resolution	Regional
Documentation	RIVM report 734301029/2007
External reference	

B.13 Ecological risk of soil contamination

In soil genesis the bioweathering of rocks (breakdown by mosses, lichens, fungi, bacteria and plant roots growing on the surface of the rock) is one of the significant mechanisms, beside the physical weathering by wind, water and temperature changes (JRC 2010, p.38). Biological processes in the soil contribute to structure of the soil by the formation of a top layer, with its essential organic matter content, fertility and water storage capacity. The top layer is the contact plane of the soil with living people.

The formation of deserts shows the importance of a top layer with functioning biological processes for maintaining the levels of organic matter, nutrient and hydrological cycles and to prevent wind and water erosion. The formation of peat soils is the result of biological processes and provides a large carbon sink essential for climate sustainability. The inflow and outflow rates of water in the soil are essential in hydrological cycles, in which the soil acts as a regulating buffer. These rates and the buffer capacity are largely dependent on soil fauna and vegetation (soil structure/macro pores and leaf evaporation). These effects support climate sustainability and flood prevention. Biological activity in the rhizosphere supports fertility. In spite that the soil species are almost invisible and not inviting to be cuddled, the conclusion is that soil biology, is worth to be watched, studied and supported.

The soil ecology also plays a role in the assessment of soil contamination. To decide on the risk level of the contaminants, several effects are considered: human health, dispersion to ground water and/or surface water, ecological risks, economic risks (e.g. polluted agricultural products, suitability as building grounds). When a harmful level of pollutants is found over a substantial area the consequence is, or should be, soil cleaning or management measures to reduce exposure levels and/or the mobility of the contaminants.

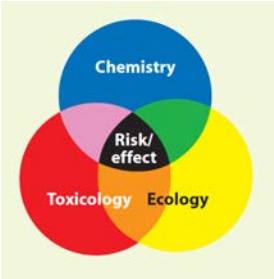
Generally the assessment of a site starts by comparison of contamination levels found in a soil investigation over a substantial area with the threshold values. These threshold values incorporate both the effects on objects of interest and the expected level of exposure. The objects can be humans or ecological objects[16]. The objects and exposure levels may vary for each site. The start is usually a generic approach on the basis of general models for the mobility of contaminants (connected with classes of land use) and the exposure of the involved objects. After the generic approach there can be an agreement on action or a discussion on the need and expenses. In the latter case a more location specific approach can help. The process of the derivation of threshold levels and of the location specific investigations are split up in human effects, ecological effects and mobility/dispersion levels. The reason for the latter is drinking water protection but also the protection of neighbouring lands and an expected increase in cleaning costs as a result of the dispersion of pollutants. In this use case description we consider the ecological risks only.

To evaluate the ecological risks the Netherlands developed a system based on the potentially affected fraction of multiple species (MS-PAF, see Posthuma and Suter in Swartjes, 2011). Data on the effect of chemical components on species are collected and combined (in the form of SSDs –species sensitivity distributions) to make estimations of the concentration level for which 5% of all species present (and/or SSD available) are adversely affected (to obtain the baseline level) or the level for which 50% of the species are adversely affected (to obtain the threshold level –related to ecology). The data on the sensitivity of soil organisms for chemical compounds are obtained from databases like the American ETOX Database (*http://cfpub.epa.gov/ecotox/*) of the EPA and the Dutch e-toxBase (*http://www.e-toxbase.com/default.aspx*) of RIVM. The developed model and necessary data are integrated in the Sancrit system (with parallel developments for human risks and dispersion). To make a formal decision on the need of site remediation or management based on detailed site investigations, the use of the Sancrit system for the evaluation of risks is obligatory in the Netherlands,.

[16] In relation to other objects: the possible damage to constructions may also be dealt with in terms of the costs of technical protection.

After the first generic approach there may rise a discussion on the need of remediation/site management, considering the costs. This is often emphasized when the main reason for action is the ecology. For such cases, where the evaluation is focusing on ecological effects, the Triad-method (Jensen, Mesman eds, 2006) has been developed. This method aims to give a systematic evaluation of the more detailed studies on ecological effects. This method combines the results of three types of investigation:

1. Chemistry: measuring the of levels of chemical components in the soil;
2. Toxicology: bioassays (laboratory tests with e.g. plants, earthworms);
3. Ecology: field observations (condition and variation of soil organisms, plants, trees).



Schematic presentation of the Triad

The basis of the Triad method is to compare results from a polluted site with the results from a non-polluted site with similar soil characteristics. An alternative is to compare the observations of soil organisms with available data on soil organisms obtained from numerous soil samples taken throughout The Netherlands and collected in the RIVM Soil biology –database (in preparation to go online, see also Rutgers, Mulder, Schouten, 2008 for characterizing reference situations).

The Triad method assists to provide a 'Weight of Evidence' of the ecological effects from the three types of investigation. Like other methods for soil surveys and investigations the Triad method can be applied in a stepwise (tiered) way, from simple to more elaborate methods and investigations, in order to exploit the research in a cost-effective manner.

Triad aspect	Parameter	weight factor	sample A	sample B	sample C
Chemistry	Sum TP total concentrations	1	0.00	0.76	0.92
	Sum TP porewater concentrations	1	0.00	0.62	0.75
	effect (chemistry)		**0.00**	**0.70**	**0.86**
Toxicology	Microtox	1	0.36	0.21	0.70
	Earthworm test	1	0.00	0.00	0.52
	Germination test	1	0.00	0.05	0.20
	effect (toxicity)		**0.14**	**0.09**	**0.30**
Ecology	Nematode community analysis	1	0.00	0.50	0.55
	Microbial parameters	1	0.00	0.25	0.45
	Micro-arthropod community analysis	1	0.00	0.15	0.32
	Plant community analysis	1	0.00	0.00	0.60
	Earthworms	1	0.00	0.45	0.24
	effect (ecology)		**0.00**	**0.29**	**0.45**
Effect assessment chemistry		1	**0.00**	**0.70**	**0.86**
Effect assessment toxicology		1	**0.14**	**0.09**	**0.51**
Effect assessment ecology		1	**0.00**	**0.29**	**0.45**
Integrated assessment (risk)			***0.05***	***0.42***	***0.67***
		deviation	0.14	0.55	0.38

Output of the Triad method: risk evaluation of the soil samples B and C (with sample A as clean reference) by 'Weight of evidence' of the chemical, toxicological and ecological investigation.

The main subject of ecology is the description of existing communities, e.g. plant communities, foodwebs, the way in which these communities shape the environment and their use and importance from the human viewpoint. For the expression on the surface this topic is most probably covered by the TWG Land cover. For the part that takes place in the soil this should be considered the topic of the TWG Soil. For the construction of the aspired data structure on soil by TGW Soil it is important which quantitative measurements of biological parameters on soil ecology and soil eco-toxicology may be encountered. The list below gives a general structure:

- the number of certain organisms in a volume of soil, pore water or connected with a certain surface [abundance per m2 and taxonomic count per 100 individuals]. Examples are the biomass and number of species like earthworms, nematodes (or eelworms), micro-arthropodes (mites, spiders and insects like springtails), microbes, algae, fungi (to be subdivided by the specialization in feeding on wood, dung, litter or association with roots); additionally the biomass of roots or root density (or length and branching). More examples of specimens can be found in: the online European Atlas of Soil biodiversity, JRC 2010);
- the measurement of general macro-parameters specific for biological performance, like the rate of natural decay of organic materials – carbon mineralization [typical in mg /ha /week], certain general enzyme activities in soil, soil breathing and or general genetic diversity analysis;
- the availability of contaminants to plants, soil organisms, earthworms, as sampled in the field or in controlled studies of bioassays (i.e. in material from plants potted in soil from a site and grown in standard conditions or with soils spiked with selected contaminants that were encountered in the field, ignoring the complete mix of pollutants and the 'ageing' of the pollution which may effect the availability) [unit: mg/kg dry weight of selected plant material (i.e. leaves, stems, bulbs, roots), for crops of edible plant material] or alternatively with simulated '(bio)availability tests' (i.e. with Ca-solutions of standard dilution) [unit in mg/kg dry weight of soil];
- decay of organic pollutants by micro-organisms or plants (phytoremediation) [unit mg/kg ds /year];

- effect of pollution on organisms (germination rate, phytotoxicity as measured by growth rate or chlorophyll content) and the effects of pollutants on plant cover and wild life in the field, decline of valued species (e.g. decline of birds of prey as a result of pesticide residues) [species count], but also adaptation of ecosystems (e.g. more nettles).

These surveys and studies are related to agricultural fertility assessment. An important issue is the valuation of ecological effects and ecosystem changes. In the Triad method similar sites that are not polluted are used as a benchmark. The concept of ecosystem services relates ecosystem performance to usefulness (see: Rutgers, Mulder, Schouten, 2008 and JRC, 2010, p.37 and p.48).

References:

Jensen J ; Mesman M. (eds), 2006; Ecological risk assessment of contaminated land - Decision support for site specific investigations. RIVM-report *711701047* ;with contributions of Jensen J ; Mesman M ; Bierkens J ; Loibner A ; Rutgers M ; Bogolte T ; Celis R ; Dirven-van Breemen EM ; Erlacher E ; Ehlers C ; Hartnik T ; Sorokin N ; Laak T ter; (RIVM-National Institute of Public Health and the Environment, Bilthoven, The Netherlands and National Environmental Research Institute, Silkeborg, Denmark , 2006).

Swartjes, F.A. (ed), Dealing with contaminated sites, from theory to practical application, Part IV Ecological aspects (Springer, 2011), *ISBN: 978-90-481-9756-9*

Rutgers M., Mulder C., Schouten T (eds), 2008 - Soil ecosystem profiling in the Netherlands with ten references for biological soil quality. *RIVM report 607604009/2008* (and the preceeding *RIVM report 607604006/2004*)

JRC 2010, European Atlas of Soil Biodiversity (JRC Joint Research Center European Commission, IES institute for Environment and Sustainability)- *EUR24375 EN*

(except for the book by Swartjes these reports and the atlas can be downloaded by clicking on the provided links)

Use Case Description	
Name	Ecological risk of soil contamination
Priority	Medium
Description	MS-PAF method for the foundation of the ecological part of the generic intervention value and the Triad-method: using 'Weight of Evidence' of three research fields (chemistry, toxicology, ecology) to make site-specific evaluations of the ecological risk of soil contamination
Legal foundation(s)	Ministerial Circular letter on soil remediation (2006, revised 2008, 2009), connected to the Dutch law on soil protection
Pre-condition	MS-PAF: knowledge of levels of biodiversity and decision on general goal (e.g. protection of 50% of the species). Triad methode: site with contaminated soil for which ecological effects are expected but the knowledge of the effects is considered as insufficient to decide on the need of soil cleaning/management measures.
Flow of Events - Basic Path (MS-PAF method)	
Step 1	General knowledge of the sensitivity of soil organisms for contaminants.
Step 2	Chemical analyses of soil
Step 3	Integration of the results obtained in step 1 and 2
Post-condition	Ecological risk level has been determined on a generic level
Flow of Events - Basic Path (Triad method)	
Step 1	Chemical analyses of soil
Step 2	Toxicology tests (bioassays)
Step 3	Field observations (soil organisms, plants, trees)
Step 4	Integration of the results obtained in step 1 to 3
Post-condition	Ecological risk level has been determined on a site-specific level
Actors	
End-users	• Local Authorities: municipalities, provinces • Land owners
Information provider(s)	Consultancy companies, laboratories, chemists, biologists
Information processors(s)/Brokers	Laboratories, consultancy companies
Information Source Input	
Description	• Chemical analyses from soil and water • Bioassays • Field observations
Thematic scope	Soil, land use, ecology
Base datasets	• Soil map • Ground water level (classes) • Soil and water (ground and surface) sample analysis, standard list (see 'documentation') and extensions as found necessary in investigation • Water monitoring networks
Data provider	• Consultancy companies • Laboratories (chemical, biological) • Scientists (chemists, biologists)
Scale, resolution	Regional (10.000 and up)
Documentation	Jenssen, Mesman, 2006 Swartjes (ed), 2011 Rutgers, Mulder, Schouten (eds), 2008

Use Case Description	
	JRC 2010, (see references) and Standard list of substances for environmental investigations to soil and sediments, as declared on may 30, 2008. A production of SIKB, NEN and Bodem+, related to the Dutch investigation standards NEN 5740 and NVN 5720.
External reference	
Information Source Output	
Description	Ecological risk assessment of soil contamination
Thematic scope	Decision to take action on a site with soil contamination
Base dataset(s)	ETOX (USA and Netherlands)- for sensitivity of soil organisms to soil contamination and SOIL Biology for comparison with normal levels for non-polluted sites
Data provider(s)	USEPA, RIVM-Netherlands
Scale, resolution	Area with comparable soil ecology
Documentation	See websites Etox and Sanscrit, , downloadable RIVM report on Triad method by Jensen, Mesman 2006.
External reference	

B.14 Contamination in relation to property

The law in the Netherlands demands that with property transfer of real estates a report on the soil quality is generated. According to the law the seller has a duty of giving information and the purchaser has a research duty. This generates questions by private citizens and real estate brokers to local authorities about the know pollution status of sites.

Local authorities on soil quality are the provinces and a selection of the larger municipalities. Each local authority has a geographical Soil Information System (SIS) connected with databases with information about the soil quality. These SIS databases contain information connected with the location of properties: soil investigations and historical information about activities and possible used fuel tanks at the site.

General information can be found free on *www.bodemloket.nl*. On payment some municipalities have more detailed reports available on request, generally on request of real estate brokers. Commercial parties may provide reports on general environmental data for a location, including soil information.

A report provided for the transaction contains information about the following aspects:
- General properties of the site like address, cadastral number, area and geographical information.
- All available information on the location based on historical surveys.
- Soil investigations, underground fuel tanks and data concerning activities from companies on the site.
- Environmental quality of the direct surroundings of the site. This part gives information about all soil-related activities in a range of 25 meters around the research location.
- General information about the used terminology and an explanation at the information on environment quality.

An example of a report on soil pollution for real estate brokers

A. Data about the site BW0033370

A1. Overview historical soil threatening activities

At this moment no historical soil threatening activities has been reported.

A2. Overview investigated sites

There are no soil investigations conducted.

A3. Overview present underground fuel tanks

There are no underground fuel tanks present.

B. Data in a range of 25 meters around the site BW0033370

B1. Overview historical soil threatening activities

At this moment no historical soil threatening activities have been reported.

B2. Overview investigated sites

Site 'KAT Kennemer Air Treatment' (fictional)

The research location has been registered under the name:		KAT Kennemer Air treatment (AA037503491)
The location has been registered under the address:		Koninginnestraat 131
On the basis of the available information the status of the location is:		Seriously polluted, not urgent to remediate
On the location the next formal decision has been given		Seriously polluted, not urgent to remediate
On the basis of the available information the location has got next follow up status::		Sufficiently investigated and, no follow up necessary
Type of investigation	Date research	Result research with regard to law of soil protection

		Ground	Groundwater
Remediation evaluation	-	Unknown	Unknown
Remediation plan	1995-01-06	Unknown	Unknown
Remediation investigation	1993-01-01	>I	Unknown
Closer investigation	1992-03-01	>I	>S
Exploratory survey	1987-11-01	>I	>T

Legenda

< S	No raised concentrations of contaminants
> S	Lightly contaminated (> reference value), <T
> T	Moderately contaminated (> between value), <I
> I	Seriously polluted (> intervention value)
Unknown	No information available

B3. Overview present underground tanks

Tank location TB037500154

The tank location is known under the name:					TB037500154
The tank location is registered on the following address:					Breestraat 210
Soil pollution					
On the location the following underground fuel tanks are present					
Volume(l)	Description	Remediated	Date of remediation	Kiwa registration	Remediation method
	Domestic fuel oil	No			
Remarks: not in use					

Parameters measured in an investigation to soil pollution

In the Dutch standards the following parameters are measured in a routine measurement in soil (for general soil quality certificates and at suspicion of soil contamination) by sampling and analysis:

Analyses on soil samples
- General soil properties: percentages of organic matter and clay particles.
- Metals: Barium, Cadmium, Cobalt, Copper, Mercury, Lead, Molybdene, Nikkel, Zinc (in older versions also Arsenic and Chromium – now only in sediments, but not Barium, Cobalt, Molybdene).
- Organic substances: Sum of PCBs[17], SUM of PAHs[18], mineral oil, EOX (extractable organic halogenated carbons[19])

When the number of substances that give problems is known to be smaller, as may follow from the first surveys, detailed investigations can be completed with a narrowed set of parameters.

In groundwater the standard range of analyses covers the same metals and for
organic substances: mineral oil, volatile aromatic hydrocarbons[20], volatile halogenated hydrocarbons[21].

[17] Sum of PCBs (poly chlorinated bifenyls) : PCB-8, -52, -101, -118, -138, -153, -180
[18] Sum of PAKs: naphtalene, phenanthrene, antracene, fluoranthene, chrysene, benzo(a)antracene, benzo(a)pyrene, benzo(k)fluoranthene, indeno(1,2,3 cd)pyrene and benzo(ghi)perylene
[19] organic compound with incorporated chlorine, fluorine, bromine or iodine
[20] volatile organic hydrocarbons: sum of benzene, toluene, ethylbenzene, all xylenes, styrene and naphtalene.
[21] Volatile halogenated hydrocarbons: sum of all chlorinated methanes (2,3 or 4 Cl), ethanes (2 or 3 Cl), ethenes (1 - 4 Cl), dichloorpropanes and bromoform.

In sediments and soils recently originating from sediments or with recently added sediments, the set of parameters is like the parameter set for soils. However, dependent of the use/dispersion in salt or sweet waters, there are some omissions and additions in the standard. General additions are:
- Metals: also Arsenic, Chromium
- Organic substances: pesticides (like drins and HCHs- also from pesticide production waste, DDT, DDD, DDE) and a range of chlorinated compounds (i.e. hexachloorbenzene) and tributyltin (antifouling paint for ship hulls).

For the analysis of risks from soil pollution also samples of various other media may be taken, i.e. of crops, poultry, milk, dust in residences, volatile compounds in the air of cellars and ground level crawling spaces.
For risks related to ecology sampling and analysis will be different. See the use case description 'Ecological risk of soil contamination' and for the risk to ground water for drinking water see 'Risk for drinking water wells by contamination'.

When encountering some specific polluting activities the standard parameters are extended, examples are:
- Cyanides in former gaswork areas (city gas)
- Volatile organic hydrocarbons (in soil air) for petrol service stations.
- Asbestos in areas selected by the asbestos protocol (demolition of certain buildings, raised land and roads near former asbestos industries).
- Pesticides near agricultural storage facilities (or pesticide production and storage facilities).

Other reasons for addition of substances may be visual inspection or smell observations by experienced observers. Also knowledge of the processes that took place on the site and knowledge of the amounts of chemicals used as found in archive surveys may be of help to characterize the pollution mix present.
An extended list of threshold values to decide on the need of soil cleaning or protection measures is available in the Circular letter on soil remediation, 2009.

Beside the method of sampling and analysis also on site measurements may give guiding information or additional information (handheld XRF- Röntgen fluorescence for contamination with metals or manure).

References:

Ministerial Circular letter on soil remediation (2006, revised 2008, 2009), connected to the Dutch law on soil protection
Standard list of substances for environmental investigations to soil and sediments, as declared on may 30, 2008 (Standaard stoffenpakket bij milieuhygienisch (water-) bodemonderzoek vastgesteld 30 mei 2008). A production of SIKB, NEN and Bodem+, related to the Dutch investigation standards NEN 5740 and NVN 5720.

Use Case Description	
Name	Contamination in relation with sale of properties
Priority	Medium
Description	The law in the Netherlands demands that with property transfer of real estates a report on the soil quality is generated. Each local authority on soil quality (provinces and municipalities) has a geographical information system on the soil quality. This contains information about the site properties, soil investigations and historical information about activities and possible used fuel tanks at the site.
Legal foundation(s)	National regulations for property transfer of real estates.
Pre-condition	Measurements and observations on soil and ground and surface water.
Flow of Events - Basic Path	
Step 1	Record geographical information of location
Step 2	Record the soil investigations and remedation actions on and near the site.
Step 3	Record the presence of used fuel tanks on or near the site.

Use Case Description	
Step 4	Present if available the historical activities on the site.
Actors	
End-users	• Provinces • Cities • Real estate brokers • Citizens that are selling or buying real estate
Information provider(s)	Provinces, regional and local government
Information processors(s)	Private and public→ data collection companies, Laboratories, consultancy companies
Information Source Input <list what the outcome of the use case will be. If more information sources are produced list each source separately>	
Description	• Previous soil investigations • Historical activities • Used fuel tanks
Thematic scope	Soil status
Base datasets	• Soil map • Soil and water (ground and surface) sample analysis
Data provider	Soil bureaus Water authorities Environmental agencies
Scale, resolution	Regional (50 m^2 and up)
Documentation	Wet bodembescherming – Netherlands Law on soil protection Ministerial Circular letter on soil remediation (2006, revised 2008, 2009), connected to the Dutch law on soil protection Standard list of substances for environmental investigations to soil and sediments, as declared on may 30, 2008. A production of SIKB, NEN and Bodem+, related to the Dutch investigation standards NEN 5740 and NVN 5720.
External reference	
Information Source Output <list what the input of the use case will be. If more information sources are needed list each source separately>	
Description	Output will represent , usually in a report with a map where restriction zones and limitations are present
Thematic scope	Soil status
Base dataset(s)	• Previous soil investigations • Historical activities • Used fuel tanks
Data provider(s)	Provinces, regional and local government
Scale, resolution	Regional (50 m2 and up)
Documentation	Law of soil protection
External reference	**www.bodemloket.nl**

B.15 State of soil in Europe

Internationally and nationally focus is on the change of state of soils. This information is used in the debate around different environmental, agricultural and climate related themes. For the characterization of the soil state and the soil development there is a need for a systematic soil monitoring approach. Most of the member states practice a nationwide monitoring network: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Lithuania, Latvia, Malta, Northern Ireland, Netherlands, Poland, Portugal, Romania, Scotland, Slovenia, Slovakia, Spain, Sweden, UK (ENVASSO, 2008).

Therefore the central aim of a monitoring network with fixed large or minor time steps is to give a documentation of the state and trend about soil related data and properties with the highest repetitious accuracy and standardization. In this sense monitoring data provide the opportunity to describe and asses the most important soil threats at a fixed time step for a nationwide purpose. Therefore the data should be suitable to advance the European Soil Strategy on the appropriate scale.

The only European wide integrative monitoring network is the ICP forest soil monitoring.
The other monitoring networks deal with minor different purposes and strategies. Often the purpose is to describe the soil quality with parameter groups of nutrients, heavy metals, organic pollutants (in general pollutants), soil contamination and rarely soil physical data, soil erosion or soil biodiversity. Sometimes the purpose is to describe the soil types and to derive soil variety.
In many cases the most important thing of a monitoring, the sampling in fixed time steps is given and European wide exist several number of campaigns.

In addition soil monitoring data allow an estimation of the success of environmental measures, the validation of modelling (climate change, nutrients, deposition e.g.), scientific research projects and also well know sites for several purposes (licensing proposes, threshold derivation). Due to the fact of an appropriate interpretation the results may contribute the development of methodologies to restrict degradation of landscape, apply standards of sustainable development in agriculture (e.g. nutrient balance) and European, national, regional or local strategies of soil (environmental) protection and prevention. The systematic monitoring approach provides the warranty to derive the state and development of soil organic carbon and related to this the national Kyoto reporting. In general, soil monitoring is the central element for environmental monitoring.

Due to the complexity of deriving soil related data a lot of stakeholders with different requirements on different levels but in the end similar aims participates (e.g. EU, member states, federal states, interest groups, companies, consulting networks, universities, public). The different stakeholders deal and work with the soil related monitoring data in a different manner and a different degree of strength (e.g.: generator, owner, users).

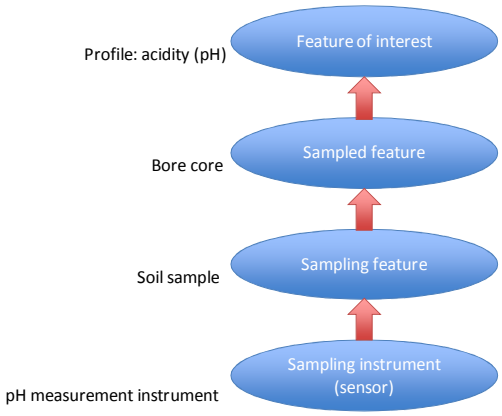
Use Case Description	
Name	*Soil monitoring in Europe.*
Priority	*High*
Description	*Member States provide soil related monitoring data to characterize soil state, soil quality and soil development in order to describe the influence of anthropogenic activities on soils*
Legal foundation(s)	*legislations of the member states and improve the legislation of the member states, improve the European soil strategy, environmental reporting of the member states (e.g. Kyoto reporting – soil carbon state) and environmental reporting of the European authorities (e.g. SOER)*
Pre-condition	*field samples have to be taken in systematic time steps and with repetitious accuracy as well as in analytics*

Use Case Description	
Flow of Events - Basic Path	
Step 1	*member states collect and store the harmonised raw data*
Step 2	*member states make further assessment with the raw data*
Step 3	*member states give a report on aggregated data, interpreted data and specific questions*
Step 4	*member states make the results available*
Post-condition	*stakeholder and interest groups can use the results (not raw data) for further investigations, reporting and policy developement*
Actors	
End-users	- *Member States* - *European institutions* - *Scientists* - *Citizens* - *Professionals (e.g. Agri-environmental business)* - *interest groups (consulting networks)*
Information provider(s)	*Member States*
Information processors(s)/Brokers	*Member States authorities responsible for providing nationwide aggregated and interpreted data*
Information Source Output • *Reports on the state and change of state of soils* • *Point Maps that provide the aggregated measurements an values from the monitoring sites* • *Maps on an appropriate national level or raster format that show the state and the development of soil related interpreted data.*	
Description	
Thematic scope	*soil, climate, land cover/use*
Base datasets	• *characterization of the monitoring site (e.g. climate, land use)* • *characterization of the soil type and the associated soil properties* • *aggregated data of the soil monitoring parameters and measurements at different time steps* → *chemical parameters (active/ exchangeable soil reaction, available nutrients, microelements, sorption capacity, organic matter content, risk elements/ pollutants)* → *organic pollutants (PAH, PCB, DDx; HCH, Dioxin)* → *physical parameters (texture, density, water content)* - *biological parameters* • *interpreted data of soil state and the development of soil related data on a national level* → *e.g. organic matter content* → *e.g. risk elements content*
Data provider	*Member States authorities*
Scale, resolution	*from point locations up to national scale, depends on national focus und specific interpretation*
Documentation	- *Member states manuals and reports* - *Member states legislation*
External reference	*Member States authorities web sites*

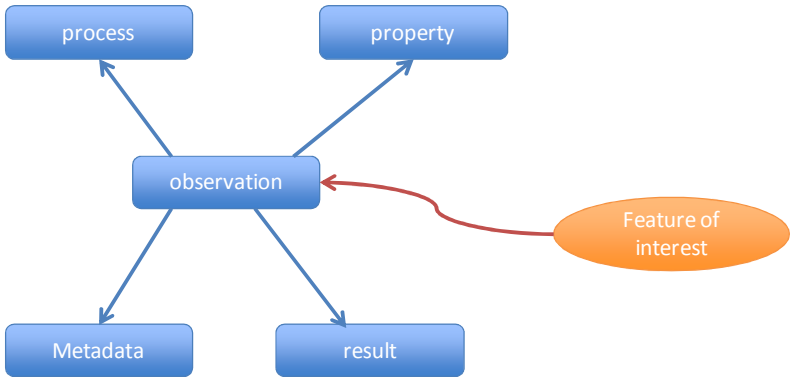
Use Case Description	
Information Source Input *Member States monitoring raw data from different authorities at different time steps.*	
Description	
Thematic scope	*soil, climate, land cover/use, climate*
Base dataset(s)	• *description of the monitoring site* → *climate data* → *landcover/ use data* • *description of the soil type and associated soil properties* • *description of the monitoring parameters and measurements with their replicates, their quality, analytical standards and sampling methods* → *chemical parameters (active/ exchangeable soil reaction, available nutrients, microelements, sorption capacity, organic matter content, risk elements/ pollutants)* → *organic pollutants (PAH, PCB, DDx; HCH, Dioxin)* → *physical parameters (texture, density, water content)* - *biological parameters* *as point maps and/or databases*
Data provider(s)	*Member states authorities on different levels and different responsibilities*
Scale, resolution	*point locations*
Documentation	- *Member states manuals and reports on different levels*
External reference	*none*

Annex C
(informative)
Use of Observations and measurements

For the data specifications of soil we use the Observations & Measurements standard. If we use as an example the acidity of the soil at a certain depth interval we distinguish in the O&M concept the following notions. The Acidity in the profile is considered to be the Feature of Interest. The bore core, being the complete profile retrieved form the bore hole is the sampled feature. At the depth interval a soil sample from this complete profile is taken to determine the acidity, the sampling feature. And the measurement itself is done with a pH measuring device, the sampling instrument. This is shown in the following figure:



The Observations & Measurements standard defines a domain independent, conceptual model for the representation of (spatiotemporal) measurement data. ISO defines an application schema as a conceptual-al schema for data required by one or more applications. O&M can be used as a generic means to deal with measurements in a standardized way.
The simplified observation model as designed in O&M is shown in the following figure:



An observation has a relationship to a procedure representing the process which has performed the observation, e.g., a physical sensor, instrument or a human observer. The observed property points to a description of the property which is observed (e.g., salinity, water depth). The observation‘s result is not restricted to a certain type in the basic observation model and can be of any type, ranging from a single measurement to an n-dimensional coverage of values. Subtypes of the basic observation then restrict the type of the result. The feature of interest, the computational representation of a real world feature (e.g., —soil profile or —water gauge) carries the property which is observed. The observation provides a value for this property at a certain time, the phenomenon time. In addition to the

phenomenon time, an observation contains two other temporal properties: result time and valid time. The mandatory result time property represents the time when the observation‘s result was produced.

Spatial information for an observation is usually given by a location property of the feature of interest. However, in O&M a spatial profile facilitates the provisioning of an observation‘s sampling geometry being the spatial extent that the result of the observation applies to. This is usually the extent of the observation‘s feature of interest. Without the profile, this information has to be extracted from the feature of interest, which could involve complex computations of the actual geometry and can also require dealing with previously unknown feature types. The related observation property can be used to express relationships between observations. In the O&M data model containers for multiple observations are now defined by the specific service specifications or applications using O&M.

In the model all the information related to the observation is considered to be the evidence of the value of the property belonging to the feature of interest. This evidence is associated to the feature if interest. In the soil application schemas all the objects containing observation are associated by the abstract class Feature of Interest to the observation related data. Since the result may vary with the particular property (typed Any) this application schema is not hard typed to cover all the possible outcomes. It serves as a pattern to be used in that particular case.