RegioneEmilia-Romagna

servizio geologico sismico e dei suoli

INSPIRE Annex II+III themes.

Data specification testing

Theme: SOIL

Edited by:

Paola Tarocco
Marica Landini

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SOIL CORE MODEL TESTING

The proposed INSPIRE Soil Core Model has been tested using the Excel Matching Tables.

The Conceptual Scheme of Emilia-Romagna Soil Information System (named **SGBDSUOLI)** is fairly different from the Inspire Model, but in most of cases data transformation has not been not too difficult.

However some difficulties have been encountered in the value type **MEASURE** because information about procedures to measure or to assess data (e.g. analytical methods, pedotransfer functions, expert judgement etc) are not provided.
Especially information about laboratory analytical method is assumed to be very important: e.g. official italian analytical methods prescribe 1:2.5 water pH and not 1:1 water pH; CaCl2 pH values are different from water pH and not comparable.

In SGBDSUOLI each variable has own instance-specific metadata providing:

- source
- determination method
- quality valutation

In the XML code (see Example) an extension of the value type Measure has been added in :

ChemicalParametersType	• baseSaturation • carbonateContent • cationExchangeCapacity • organicCarbonContent • pH

```
<complexType name="MeasureType">
  <simpleContent>
    <extension base="double">
      <attribute name="uom" type="anyURI" use="required"/>
      <attribute name="method_description" type="string"/>
    </extension>
  </simpleContent>
</complexType>
```

In SGBDSuoli it is possible to add this extension in the following objects as well:

ObservedSoilProfile	• availableWaterCapacity • potentialRootDepth
DerivedSoilProfile	• availableWaterCapacity • potentialRootDepth

In the table below evaluations about data transformation are reassumed.

Type	Attribute Association role Constraint	Status	Remarks
SoilType		Easy	Soil Taxonomy is the reference Classification. There is not a fixed edition. The latest update refers to 2003
	soilName	easy	Soil Taxonomy is the reference Classification
	soilClassificationScheme	easy	Not present in database structure but easy to obtain
SoilPlot		easy	The database structure is similar
	inspireId	easy	The database structure is similar; observed soil profiles and monitoring points are in different tables
	soilPlotLocation	easy	The database structure is similar
	soilPlotType	easy	The database structure is similar. Translation to INSPIRE codes is easy
	beginLifespanVersion	easy	The database structure is similar

Type	Attribute Association role Constraint	Status	Remarks
	endLifespanVersion	easy	Never populated. An observation site doesn't loose validity. A wrong soil plot is deleted
	isSampledBy	easy	In the database structure soil samples are related to soil horizons but it'not difficult to extract them.
	locatedOn	easy	The concept of soil site is not clear. Can it be similar to soil investigation area?
	observedProfile	easy	Soil plot and observed soil profile are the same thing
SoilLayer Supertypes: *ProfileElement* *GFI_Feature*	**inspireId**	easy	
	profileElementDepthRange	easy	
	chemicalParameters	easy	
	beginLifespanVersion	easy	Is taken from the reported monitoring site. Not very interesting: sampling date is more important
	physicalParameters	easy	
	contaminant		
	endLifespanVersion	easy	Is taken from the reported monitoring site. Never populated
	isPartOf		
	layerType	easy	Usually 20-30 cm; 120-130 cm; 0-30 cm
	layerGenesis	Not available	
	layerRockType	Not available	
WRBSoilType		Difficult	Often not populated. The database structure is not ready for WRB 2006 specifics. It refers to 1998 edition
	referenceSoilGroup	easy	The same values are used
	qualifier_1	easy	The same values are used
	specifier_1	easy	The same values are used
	qualifier_2	easy	The same values are used
	specifier_2	Not available	
	qualifier_3	Not available	
	specifier_3	Not available	
	qualifier_4	Not available	
	specifier_4	Not available	
	qualifier_5	Not available	
	specifier_5	Not available	
	qualifier_6	Not available	
	specifier_6	Not available	
SoilComplexLabelType		easy	The database structure is similar
	soilComplexName	easy	Every mapping unit ID is different according to different mapping scale. EXAMPLE: 0005 for 1:50,000 scale; B2d1 for 1:250,000 scale. Used only for mapping scale from 1:250,000 to 1:10,000.
	soilComplexClassificationScheme	easy	The classification schema (for 1:50,000) refers to A. Wambecke, T. Forbes. Guidelines for using Soil Taxonomy in the names of Soil Map Units. SMSS Techinical Monograph n. 10. 1986
	soilComplexDescription	easy	Always populated
ObservedSoilProfile Supertypes: *SoilProfile* *GFI_Feature*			
	inspireId	Easy	Observation site ID is mandatory. It is exactly alike of GISID
	WRBSoilType	Difficult	Often not populated. The database structure is not ready for WRB 2006 specifics.
	localSoilType	easy	Every soil profile is related to many local soil types. The latest update is used.
	availableWaterCapacity	Difficult	Never populated. Usually it is calculated for a fixed depth (0-150 cm or to a root-limiting layer). Data can be obtained by laboratory measure or making use of several pedofunction rules. Needs some work
	localIdentifier	Easy	Local identifier is mandatory
	beginLifespanVersion	easy	It's the same of the soil plot
	endLifespanVersion	easy	It's the same of the soil plot
	potentialRootDepth	easy	Often populated
	location		

Type	Attribute Association role Constraint	Status	Remarks
SoilThematicObject			
	inspireId	Easy	Thematic maps are based on 2 coverages: - 1:50.00 Soil map (SoilComplexIId is used); - 1km x 1km grid according to the ""European Grid Reference System" (See INSPIRE Workshop: "A grid for representing thematic information is a system of regular and geo-referenced cells, with a specified shape and size, and an associated property."). Cell Id is used
	geometry	easy	Thematic maps are always polygonal
	depthInterval	easy	Most common range depth are 0-30 cm; 0-100 cm; 0-50 cm; 50-100 cm; 20-30 cm; 120-130 cm
	soilThematicResult	easy	Available thematic maps are based on processing of soil samples, Observed Soil profiles, Derivated Soil Profiles and Soil Complexes. They are: - organic matter content at the depht 0-30 cm; - organic matter content at the depht 0-100 cm; - clay content at the depht 0-30 cm; - P, N, K content at the depht 0-30 cm; - Organic carbon stock at the depht 0-30 cm; - Organic carbon stock at the depht 0-100 cm; - Heavy metal pedo-geochemical content in the alluvial plain (Cr, Zn, Ni, Pb, Cu); - Soil salinity map at the depht 0-50 cm; - Soil salinity map at the depht 50-100 cm - Soil Erosion; - Land Capability; - Establishment Less Favoured Areas
	beginLifespanVersion	easy	Derived from metadata
	endLifespanVersion	easy	Derived from metadata
	isBasedOnSoilSample	easy	
	isBasedOnSoilProfile	easy	
	isBasedOnSoilComplex	easy	
RangeType			
	upperBoundary	easy	
	lowerBoundary	easy	
DerivedProfilePresenceInSoilComplex		easy	The database structure is similar
	derivedProfilePercentageRange	easy	The database structure is similar
FAOHorizonNotationType		Difficult	Horizon is not classified according to FAO classification system
	horizonDiscontinuity	Not avalaible	Horizon is not classified according to FAO classification system
	horizonMaster	Not avalaible	Horizon is not classified according to FAO classification system
	horizonSubordinate	Not avalaible	Horizon is not classified according to FAO classification system
	horizonVertical	Not avalaible	Horizon is not classified according to FAO classification system
DerivedSoilProfile Supertypes: *SoilProfile* *GFI_Feature*			
	inspireId	Difficult	In our database STU identifier is a Character String. We can obtain InspireId making use of the ROWNUM SQL syntax
	WRBSoilType	Difficult	Often not populated. The database structure is not ready for WRB 2006 specifics.
	localSoilType	easy	Every soil profile is related to many local soil types. The latest update is used.
	availableWaterCapacity	Difficult	Often not populated.
	localIdentifier	easy	STU identifier is mandatory
	beginLifespanVersion	Not avalaible	Not used
	endLifespanVersion	Not avalaible	A flag 'deceased' is used
	derivedPotentialRootDepth	Difficult	Often not populated at present.
	isDerivedFrom		
SoilSite		easy	The database structure is similar. The word "soil site" can cause confusion with soil plot
	inspireId	easy	The database structure is similar

Type	Attribute Association role Constraint	Status	Remarks
	geometry	easy	A soil investigation area is always poligonal
	soilInvestigationPurpose	easy	Not present in the database, but easy to obtain from Soil Investigation area code. EXAMPLE: M1201. The first letter M means Monitoring Survey
	beginLifespanVersion	easy	The database structure is similar
	endLifespanVersion	easy	Never used
	validFrom	easy	The database structure is similar
	validTo	easy	The database structure is similar
	isObservedOnLocation	easy	
ParticleSizeFractionType		easy	Often populated; several partcle size fraction are available
	fractionContent	easy	Almost always populated
	fractionParticleSizeRange	easy	Not present in the database but easy to produce
		easy	
ChemicalParametersType			
	baseSaturation	easy	Often not populated at present
	carbonateContent	easy	Often present
	cationExchangeCapacity	easy	Often not populated at present
	organicCarbonContent	easy	Often present
	pH	easy	Often present
SoilHorizon Supertypes: *ProfileElement* *GFI_Feature*		Difficult	Some data are not available
	inspireId	easy	The database structure is similar
	profileElementDepthRange	Difficult	Always populated in ObservedSoilProfile; in DerivatedSoilProfile only UpperValue is available
	chemicalParameters	easy	Almost always populated
	beginLifespanVersion	easy	
	physicalParameters	Difficult	Data are avalaible but it's not clear how to generate relative XML code in ISPIRE documentation
	contaminant	Not avalaible	
	endLifespanVersion	Not avalaible	
	isPartOf		
	FAOHorizonNotation	Not avalaible	
	localHorizonNotation	easy	Always populated
PhysicalParametersType		easy	
	particleSizeFraction	easy	The database structure is different, but it's not difficult the conversion in the INSPIRE structure
SoilSample Supertypes: *GFI_Feature*			
	inspireId	easy	It depends on ObservedSoilProfile
	localIdentifier	easy	It depends on SoilHorizon of the ObservedSoilProfile
	sampledDepthRange	easy	
	sampledProperty	easy	
	beginLifespanVersion	easy	Is taken from the reported observed soil profile OR from the reported monitoring site. Not very interesting: data sampling is more important
	endLifespanVersion	easy	Is taken from the reported observed soil profile OR from the reported monitoring point. Not populated
	isTakenFrom		
ContaminationType	**contaminantName**	easy	Only heavy metals content is available
	measuredValue	easy	
	contaminationSubject	easy	ContaminationSubject is soil
HorizonNotationType	**horizonNotation**	easy	
	soilDescriptionReference	easy	
SoilComplex			Why not using Soil Mapping Unit instead of Soil Complex? This name can induce misunderstanding (e.g. the meaning for USDA soil mapping unit)
	inspireId		
	geometry		
	soilComplexLabel	easy	Always populated
	beginLifespanVersion	easy	Always populated
	endLifespanVersion	easy	Used
	isDescribedBy		

USE CASE: PEDOGEOCHEMICAL MAP OF EMILIA-ROMAGNA ALLUVIAL PLAIN AT 1:250.000 SCALE

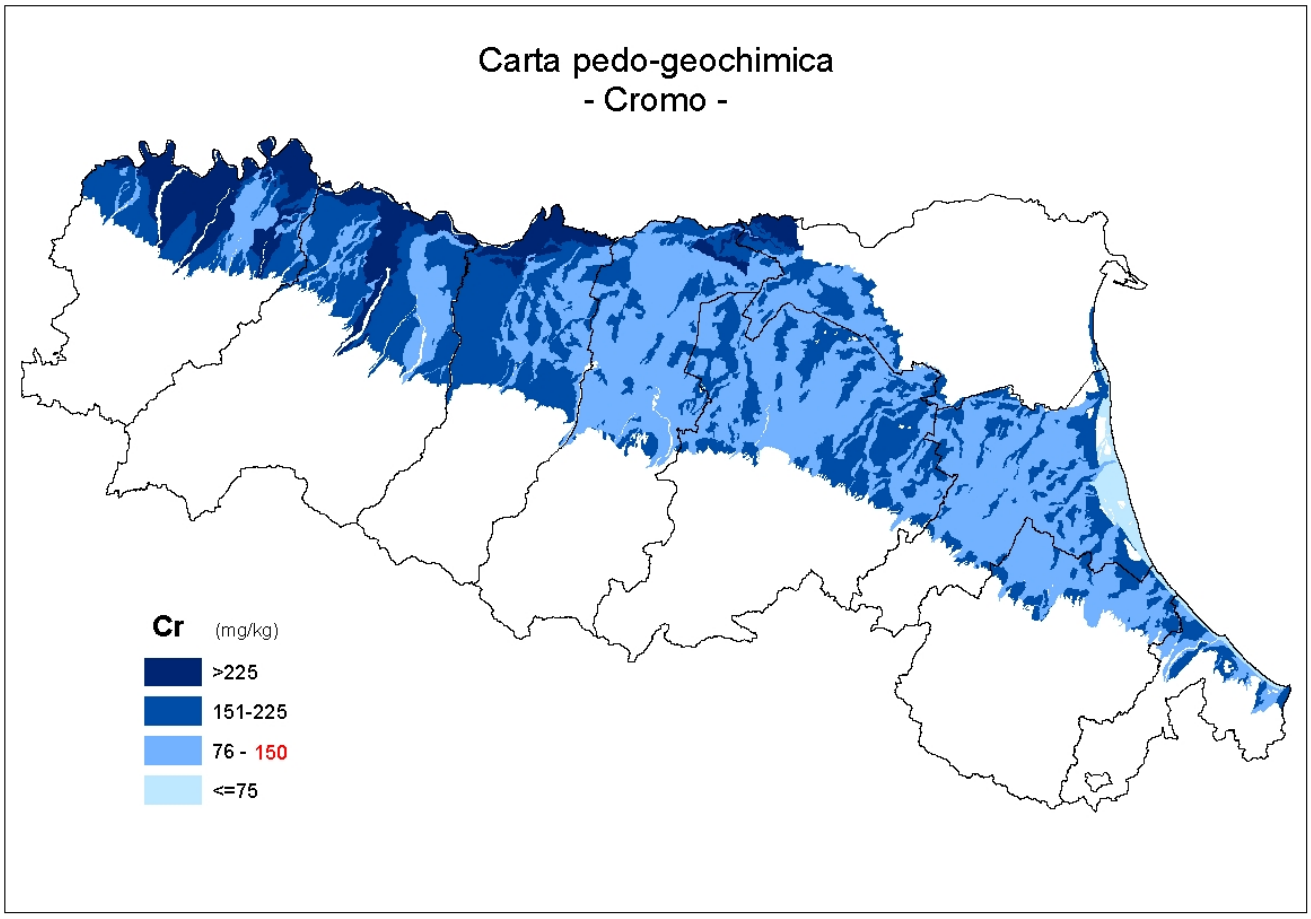

Fig. 1. Chromium pedo-geochemical map of the alluvial plain

USE CASE DESCRIPTION	
Name	Pedo-geochemical Map of Emilia-Romagna alluvial plain at 1:250.000 scale.
Prority	High
Description	This map describes the areal distribution of the natural total content of 5 heavy metals (Cr, Ni, Zn, Pb and Cu) at depth interval of 120-130 cm. This depth is regarded as representative of the pedo-geochemical content according to ISO/DIS 19258/2005 definitions. The pedo-geochemical content or natural content of metals in soils is controlled by three factors: - Parent material provenance; - Texture (grain size); - Soil weathering degree . The complex interaction among these factors can bring out in high natural concentration of potentially toxic metals in soils in some areas of Emilia-Romagna alluvial plain (e.g. in soils derived by Po river sediments). This natural concentration may exceed the threshold limits for contaminated areas fixed by Italian Law.
Legal Foundation	According to the Italian Legislative Decree 152/06 of 3rd April 2006, concerning the consolidated law governing environmental issues ("Testo Unico recante le Norme in Materia Ambientale "), the Contamination Threshold Value is defined as follows (at art.240 comma 1 letter b): *"threshold values are the values of contamination of environmental matrix above which the characterization and specific risk analysis of the contaminated site, as described in the Appendix 5 at part four of the present law, becomes necessary. In the event the potentially polluted site is located in an area where geogenic or anthropogenic factors are responsible for the exceeding of threshold values for some parameters, the background content of these background content of these parameters is assumed as threshold".*
Pre-condition	The European Soil Thematic Strategy recommends the development of information like this in the management of contamination ("soil status report" par.4.1.2.)
ACTORS	
End-users	Public Institutions at local level, Environment Local Agencies, stakeholders.
Information provider	Emilia-Romagna Region. Geological, Seismic and Soil Service. This map is available on two web sites (only in Italian language): - I suoli dell'Emilia-Romagna. In the thematic map section is possible to consult five maps (one map for each metal) on GOOGLE EARTH base. URL: http://geo.regione.emilia-romagna.it/cartpedo/carte_tematiche.jsp - Cartografia dei Suoli della Regione Emilia-Romagna. This is a WEBGIS site and information on sample points are available too. URL. http://www.regione.emilia-romagna.it/wcm/geologia/canali/cartografia/sito_cartografia/web_gis_cartografia_suoli.htm
Information processor/Brokers	Emilia-Romagna Region. Geological, Seismic and Soil Service

FLOW OF EVENTS – BASIC PATH	
This work has been going on since 2005 (it's not finished yet) through different phases: - first phase: pilot study in a selected area at 1:50.000 scale within Parma province – published in 2006; - second phase: survey and mapping of the western part of the alluvial plain (from Tidone river to Secchia river) – published in 2010; - third phase: survey and mapping of the eastern part of the alluvial plain (from Panaro river to the Adriatic sea) –published in 2011; - fourth phase: survey and mapping of the ancient delta plain of Po river to complete the whole alluvial plain. The field survey and laboratory analyses are ongoing. The ISO 19258/2005 is the reference methodology used for the compilation of the pedo-geochemical map. The followed methodology has been about the same in all the phases; only the final legend is changed during the work and in the third phase it has taken the definitive aspect.	
Step 1	**Definition of the Functional Soil Groups**. 1:50.000 soil map and basin map (available on the entire plain) has been used to characterize the high variability of chemical and textural properties. The main typological units have been grouped in 11 functional groups identified by the same provenance, grain size and weathering degree and by the same natural content of heavy metals.
Step 2	**Typological sampling**. The sampling schema is finalized to cover the wide spectrum of the soil typological units, whereas observing a nearly regular grid (1 observation every 16 square km). The 1:250.000 scale is due to a this wide grid. In the pilot area the sampling density was higher: 1 observation every 5 square km. In the selected polygons the sampling points must be chosen avoiding possible contamination. This aim has been almost achieved using all the available information: - soil map; - basin map; - geological map; - historical and present land use maps (to avoid former industrial sites and filled quarries); - aerial photographs of different years; - DTM Every sampling point (as a borehole) is described to a depth of 150 cm and linked to a Soil Regional Typological Unit. The sampling depths are 20-30 cm (to characterize the background content) and 90-130 cm (to characterize the pedo-geochemical content).
Step 3	**Chemical analyses** . They are conducted up to standard indications ISO/DIS 19528 to determine the total content on both samples using X-ray fluorescence spectrometry (XRF). For a comparison with the pseudo-total content, analyses of the superficial samples are duplicated, using both XRF and inductively coupled plasma mass spectrometry (ICP-MS), with aqua regia digestion (UNI EN 13346-2002/EPA6020) .
Step 4	**Statistical processing of data**. 1) Data distribution (Kolmogorov-Smirnov test); 2) Data normalization wherever it is necessary (Box-Cox transformation); 3) Outlier identification (by box-plot); 4) 90^{th} and 95^{th} percentile identification after outlier elimination.
Step 5	**Data presentation**. the values of pedo-geochemical background values are represented on the soil map. Kriging is not used. Each polygon of the map is attributed to a Functional Soil Group (FSG) as defined at step 1 depending on the most spread soil among the present soils. The heavy metal content is described by the 50°, 90° and 95° percentile of the FSG. Four classes are mapped for each metal, using the threshold limit fixed by Italian Law to separate the two upper classes from the two lower classes and the 95° percentile to define the boundaries between the classes. For some metals the entire map covers only one or two classes (e.g. Pb, Cu, Zn).

EXAMPLE

In the example (XML code) are both present data from Core Model and data from Use Case.

In the polygon **5226** are present the following objects:
- 1 SoilComplex polygon;
- 4 DerivedSoilProfiles
- 4 ObservedSoilProfiles
- 1 SoilLayer
- 1 Thematic Object (Pedo-geochemical Map of Chromium). In this map are indicated the 50th, 90th and 95th percentile of Chromium values (mg/kg).

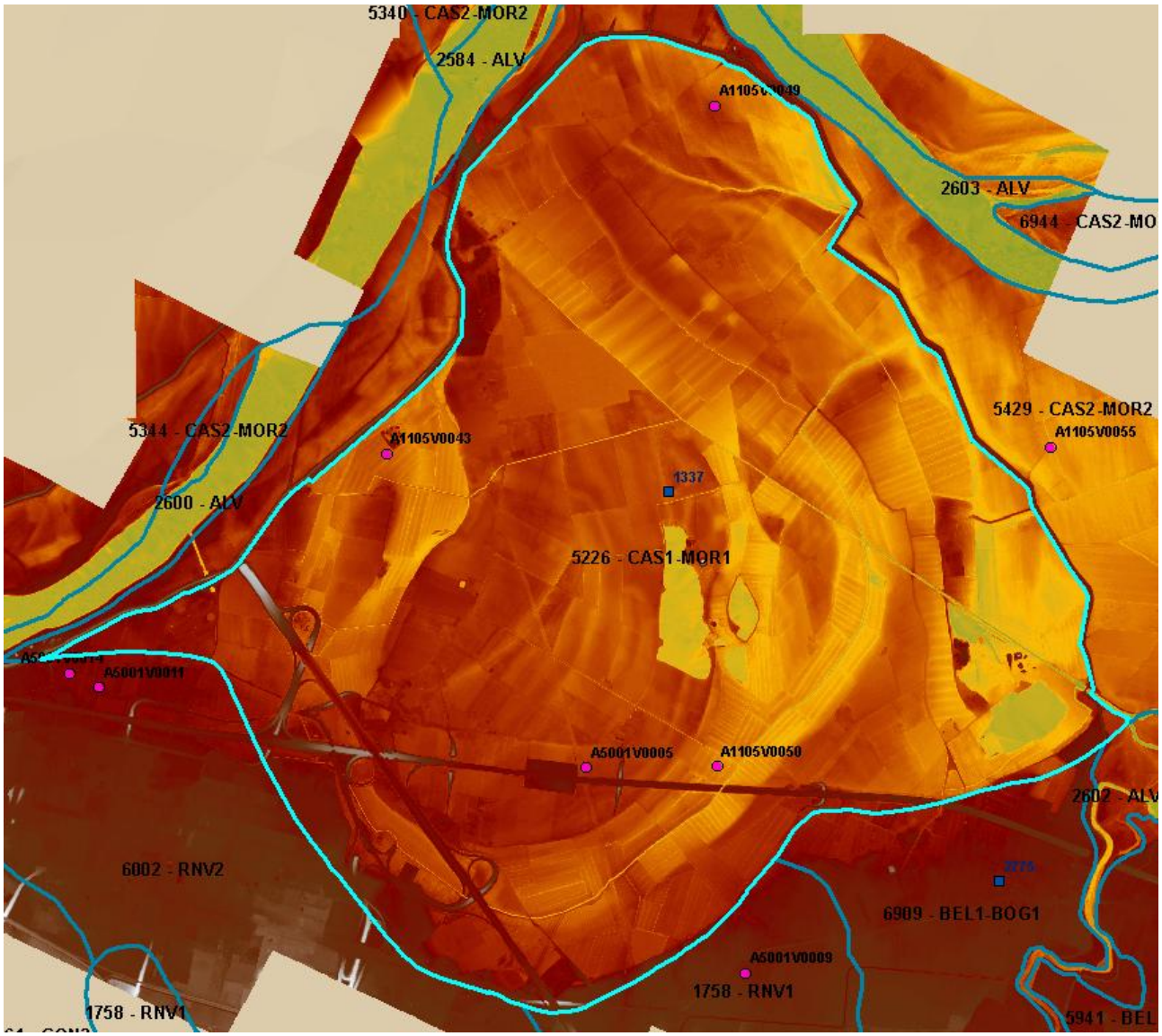

Fig. 2. SoilComplex example. Lilac points are ObservedSoilProfiles; blue points are SoilLayers. On the background Digital Terrain Model.

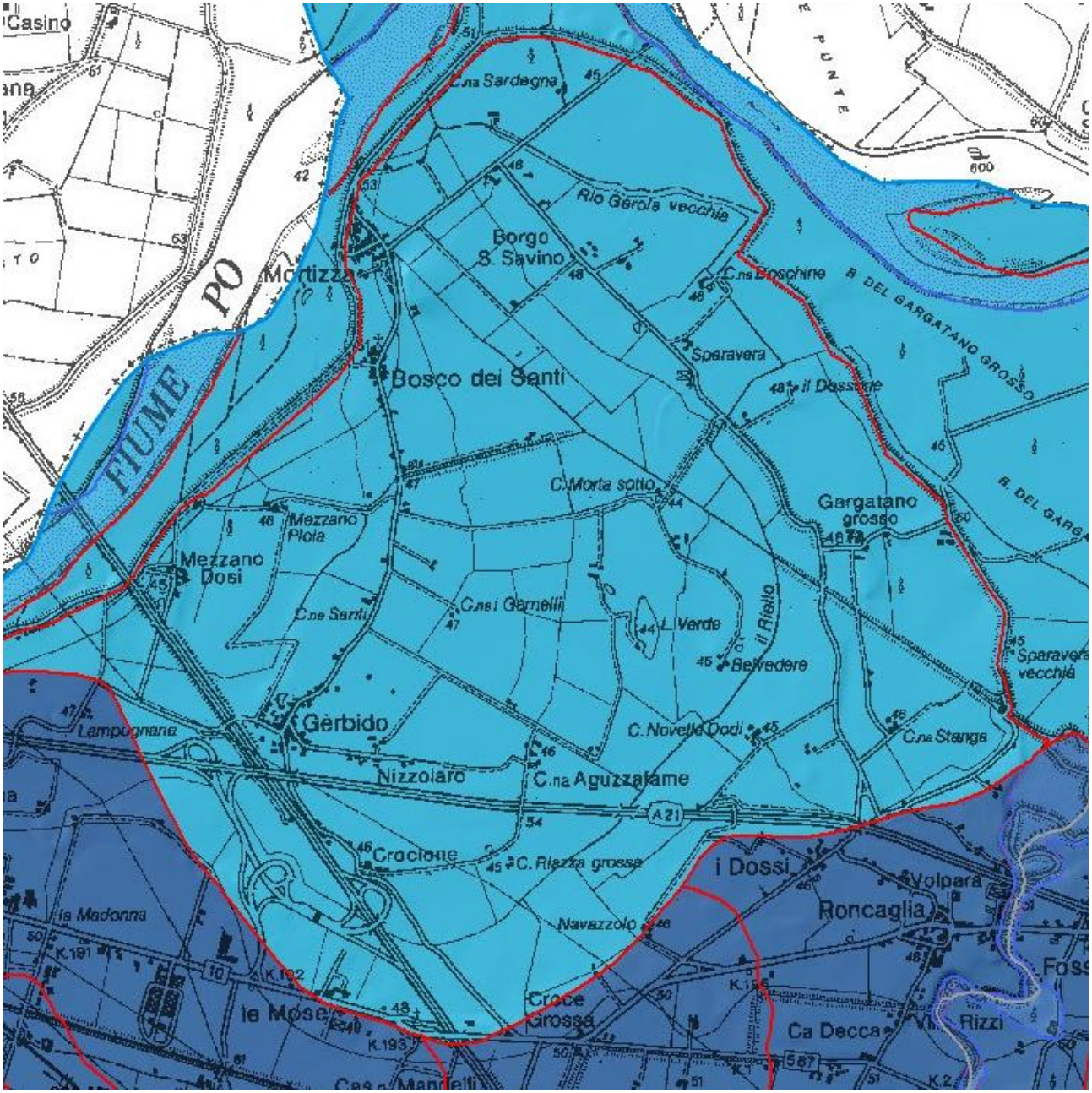

Fig. 3. Thematic object