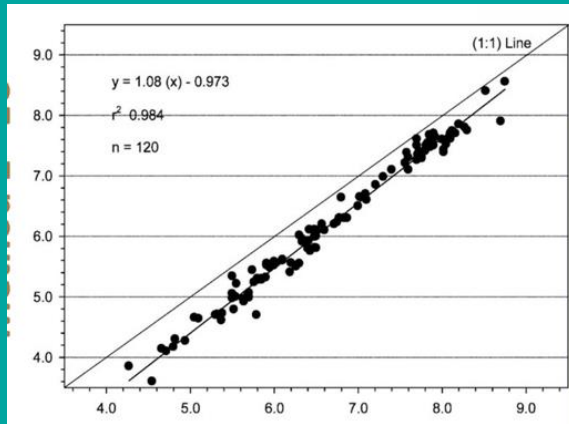


Harmonising public and private data for monitoring soil carbon dynamics.

Maria Fantappiè

Council for Agricultural Research and Economics of Italy



With the collaboration for several of these slides of the colleagues of EJPSOIL programme

Fenny van Egmond, Antonio Bispo, Claire Chenu, Bozena Smreczak,, Zsófi Bakacsi, Rudi Hessel, Johanna Wetterlind, Paul van Genuchten, Giovanni L'Abate, Andrea Lachi, Stefania Morrone

THE CARBON FARMING QUALITY CRITERIA



QUANTIFICATION



ADDITIONALITY



LONG-TERM
STORAGE



SUSTAINABILITY

[Carbon Removal Certification - European Commission \(europa.eu\)](https://europa.eu)

To secure a liveable future, the EU has committed to achieving climate neutrality by 2050. This means we need to drastically reduce our greenhouse gas emissions and compensate for residual emissions (e.g. from industry or agriculture) through carbon removals, which means **removing carbon dioxide (CO₂) from the Earth's atmosphere** via natural and technological solutions.

This [proposal](#) sets out a **voluntary EU-wide framework to certify carbon removals generated in Europe**. It sets out **criteria to define high-quality carbon removals** and the process to **monitor, report and verify the authenticity of these removals**. With this certification framework, our aim is to boost innovative carbon removal technologies and sustainable carbon farming solutions, while fighting greenwashing.

There are several ways to remove and store carbon. All can be certified under the EU's framework:

- **Nature-based solutions, such as restoring forests, soils, and innovative farming practices**

ON FAIR PRINCIPLES

Findable

Metadata and data should be findable for both humans and computers

F

A

Interoperable

Data needs to work with applications or workflows for analysis, storage and processing

I

R

Accessible

Once found, users need to know how the data can be accessed

Reusable

The goal of FAIR is to optimise data reuse via comprehensive well-described metadata

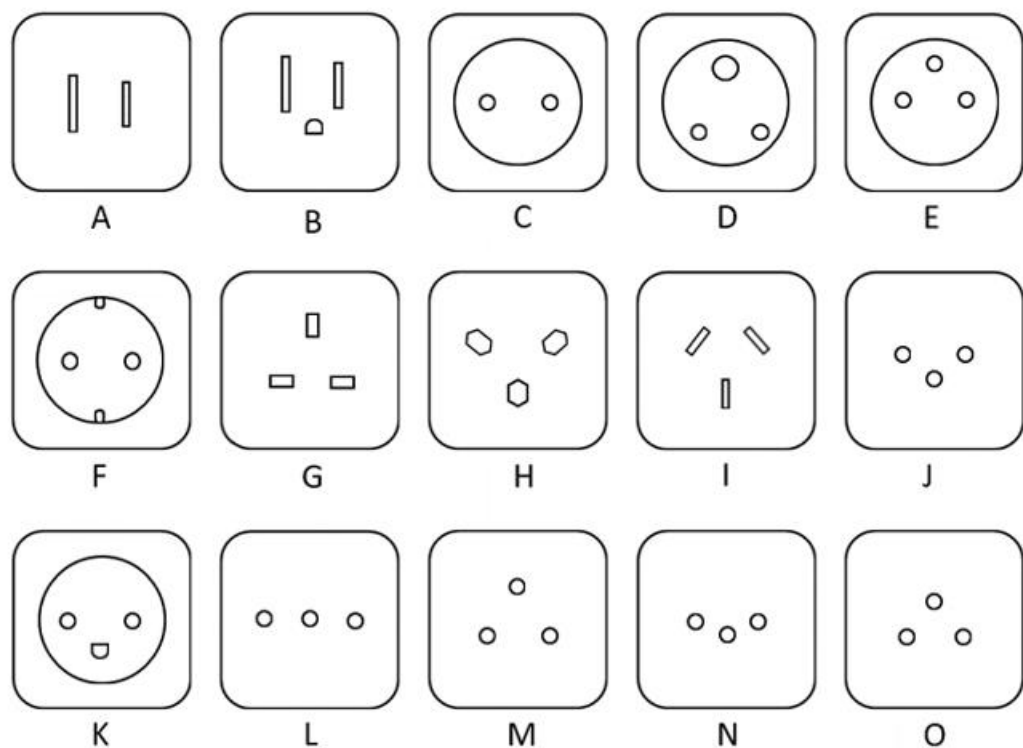
the technical contribution of EJPSOIL programme towards the implementation of these principles

<https://ejpsoil.eu/soil-research/soil-data-monitoring-mapping-and-modelling>

DATA STANDARDISATION AND HARMONISATION

STANDARDISED DATA

explicit data = FAIR



HARMONISED DATA

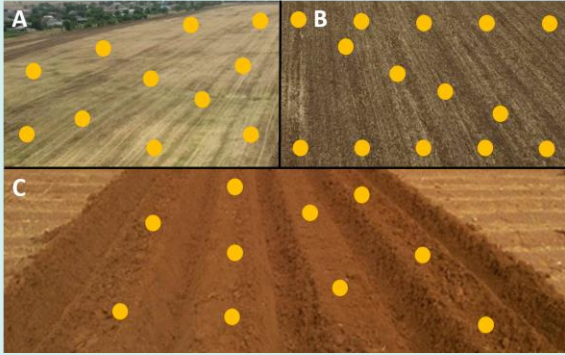
transformed data to a common standard



Standardisation is describing data in the same way (agreed definitions, structure, format)

Harmonisation is translating data to the same units, lab methods, definitions, etc.

HARMONIZATION IN SCALE AND IN TIME



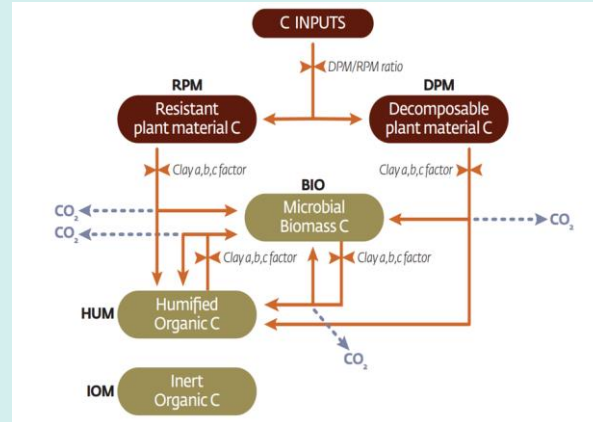
Different sampling protocols in field



Different analytical standards and procedures



Different pedoclimatic conditions



Different modeling

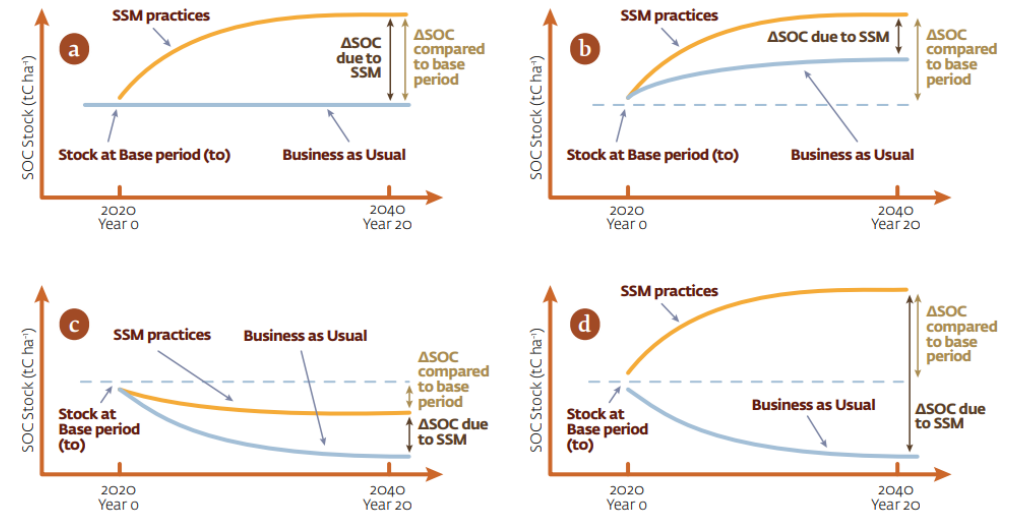
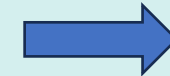


Figure 2 | Soil organic carbon theoretical evolutions under a business-as-usual (BAU) scenario and after the adoption of Sustainable Soil Management (SSM) practices. This depicts a) lands where SOC levels have reached equilibrium and it is possible to increase levels through SSM; b) lands where SOC is increasing but can be further increased through SSM; and lands where SOC is decreasing and it is possible to stop or mitigate losses in SOC levels (c), or even reverse this fall through SSM (d).

Possible different scenarios of the Business-As-Usual (BAU) due to climate change

FROM THE FIELD
SCALE
MONITORING

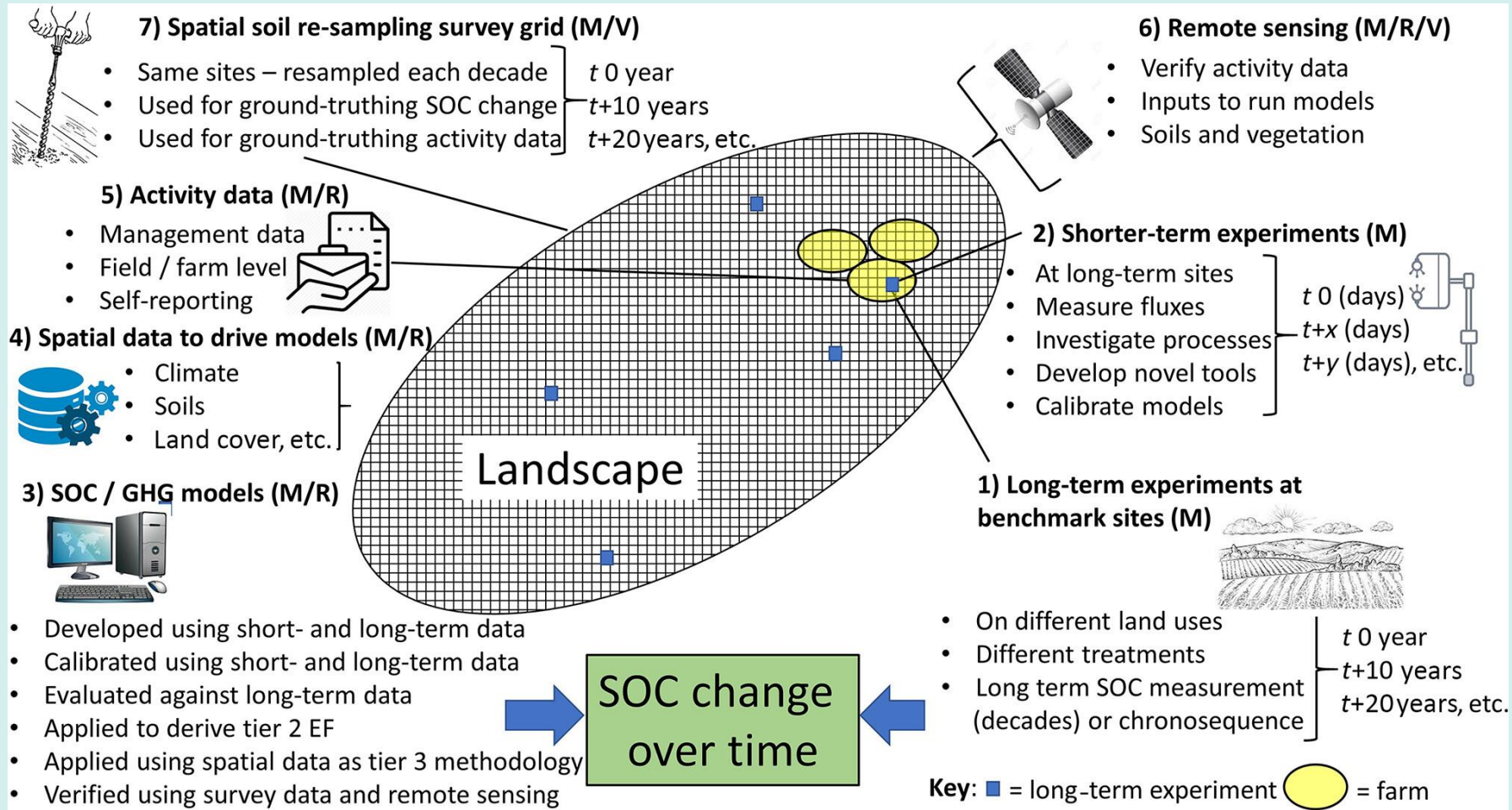


TO THE REPORTING AT
NATIONAL AND
CONTINENTAL SCALE

SOIL IS DIFFERENT IN SPACE AND IN TIME

STANDARD BASELINE ARE REQUESTED BY DG-ENV

HARMONIZATION IN SCALE AND IN TIME towards an integrated system



Smith et al.
2019

<https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.14815>

knowledge
harmonization,
organization &
storage

EJPSOIL WP6 - Supporting harmonised soil information and reporting

EU Soil
Policies for
soil
protection

Request for
soil indicators

Maps and monitoring

CURRENT SITUATION

ESDAC EU-
WIDE SOIL
MAPS &
LUCAS SOIL
MONITORING

May not be
representative

NATIONAL
SOIL MAPS &
SOIL
MONITORING

Not
EU-harmonised

EJP SOIL
WP6

EJP SOIL TECHNICAL SOLUTION

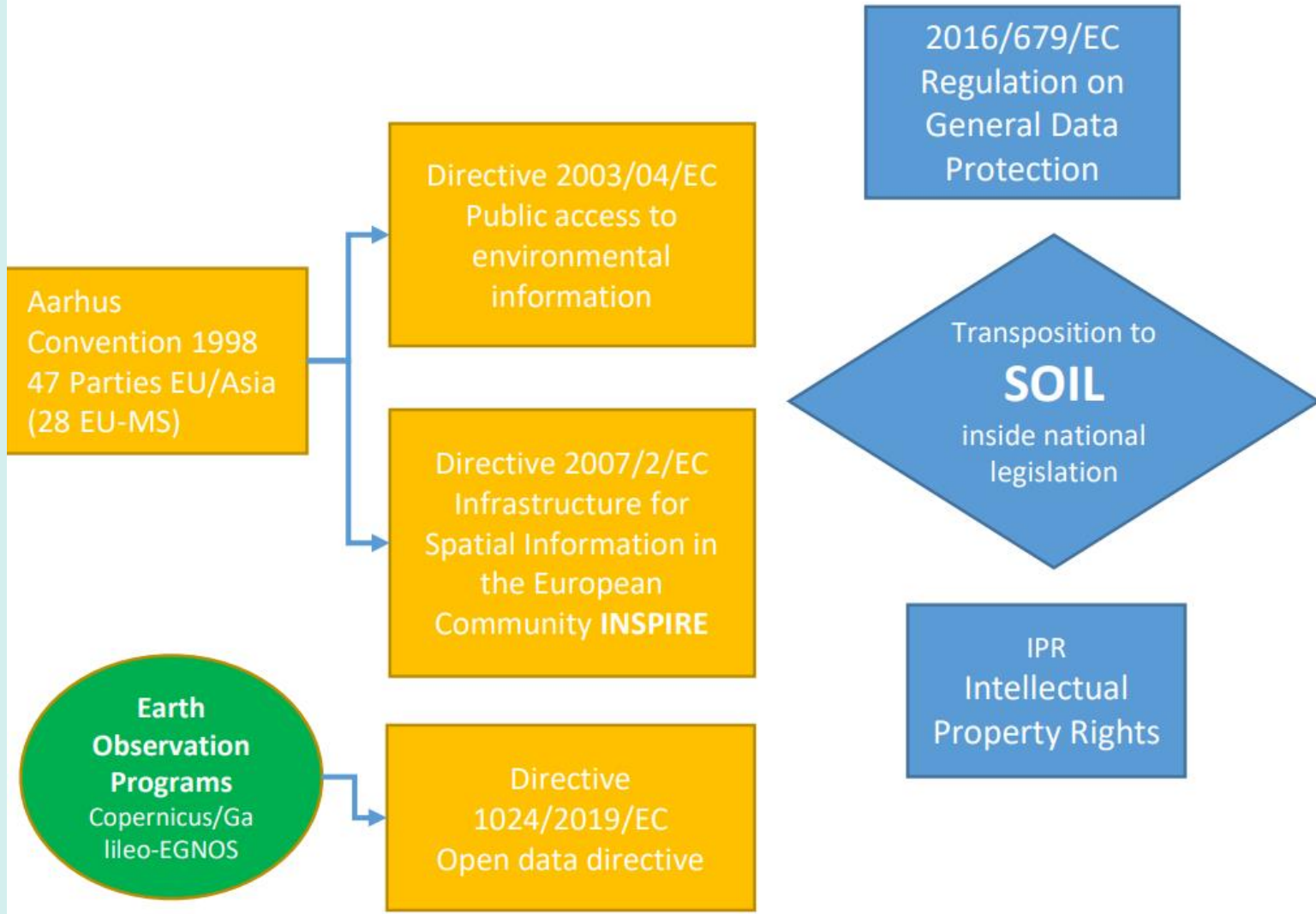
EU-WIDE
HARMONISED
NATIONAL SOIL MAPS &
SOIL MONITORING
WITH LUCAS AS *DE FACTO*
STANDARD

MEMBER STATES
DECISION

Transboundary
issues



EU LEGAL FRAMEWORK - THE CHALLENGE OF SOIL DATA SHARING



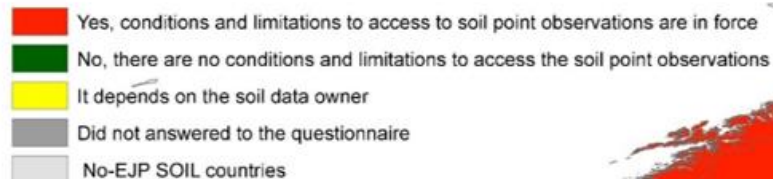
Aim : analyse the **state of implementation of the EU-Directives** and the implications linked to their transposition in relation to soil information.

Agricultural soils usually under private property in Europe, => the public right to have access to environmental information, must be balanced with the right of landowners in relation to their properties.

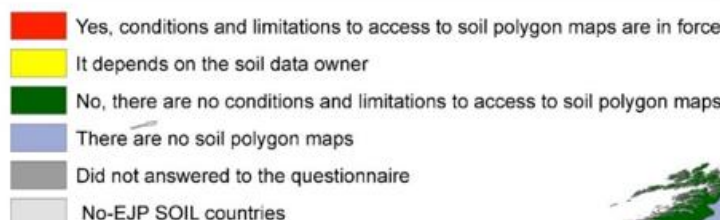
Member States are allowed a certain **flexibility in the transposition of EU-Directives, given their national legislations,** therefore the national transposition may be changed substantially.

CONDITIONS/LIMITATIONS FOR SOIL DATA SHARING

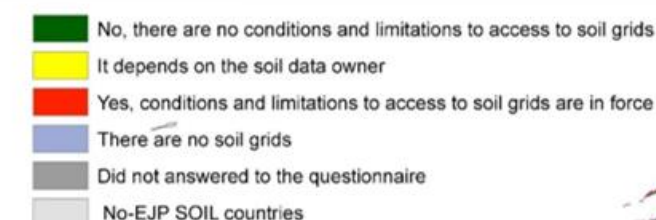
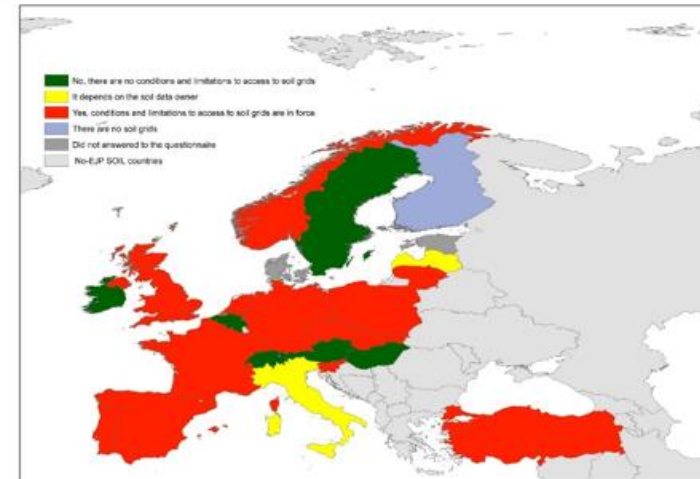
POINT DATA



VECTOR



RASTER



1. SOIL DATA OWNER INTERESTS PROTECTION(8/16)

2. GDPR(6/16) ← = soil property/farmers

3. CONDITIONS TO THE REUSE (5/16)

4. IPR (3/16)

1. IPR(5/16) ← authorship

2. SPECIFIC LICENSES(2/16)

1. CONDITIONS TO THE REUSE(4/16)

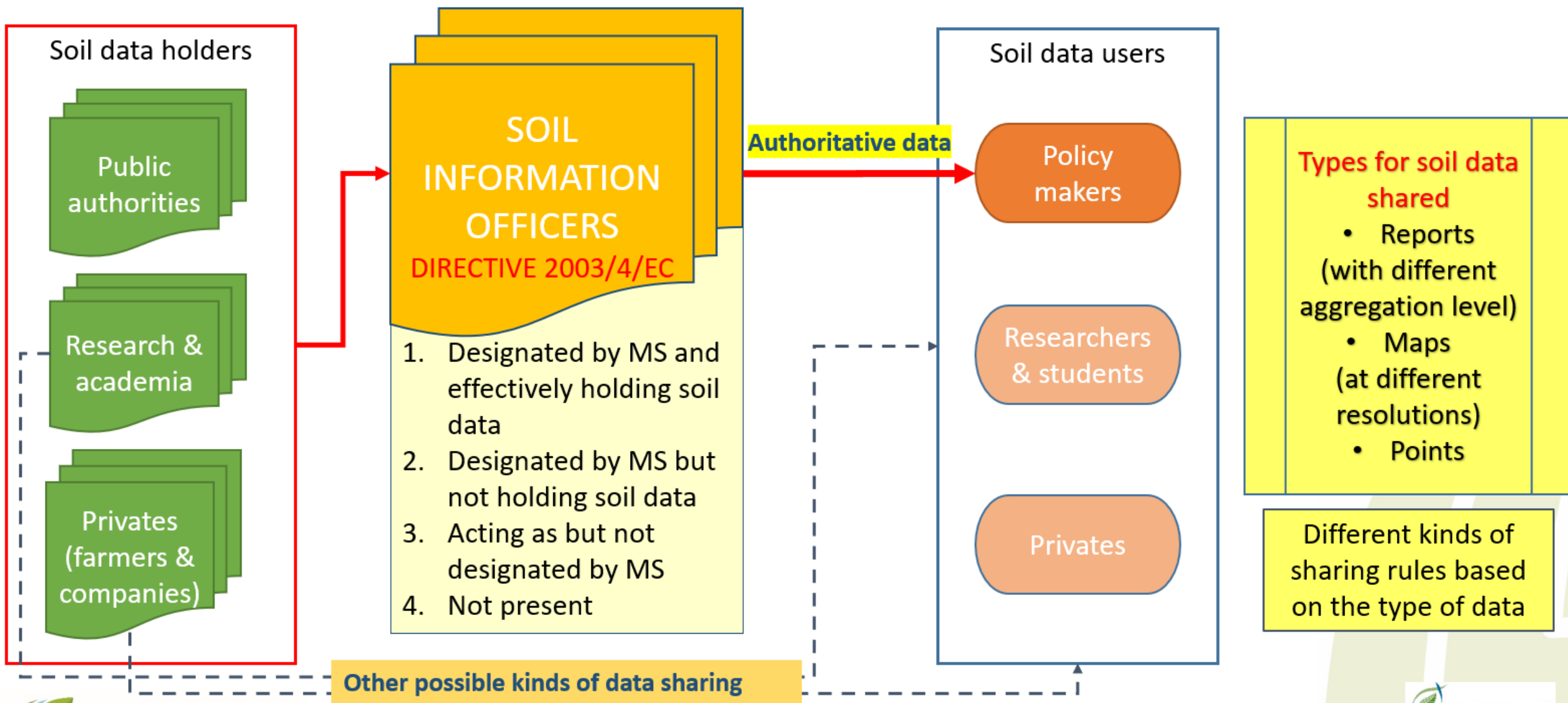
2. SPECIFIC LICENSES(3/16)

3. IPR(2/16) ← authorship

local governance

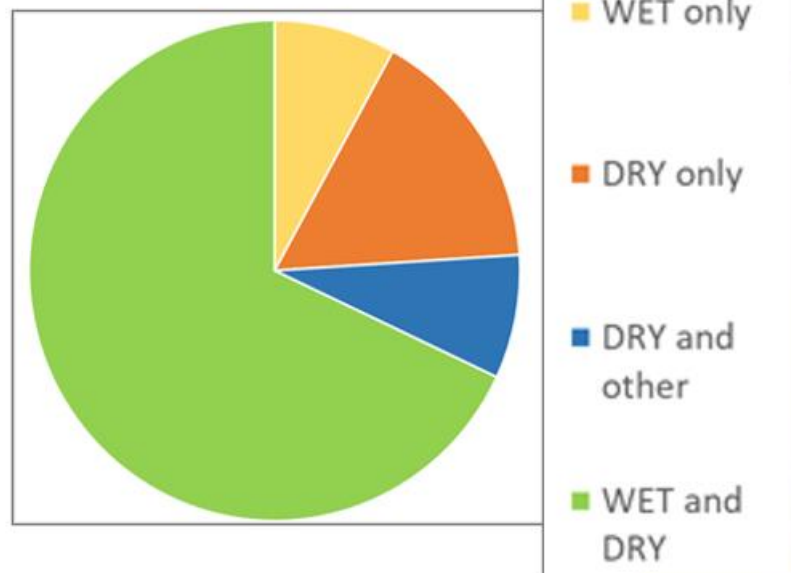
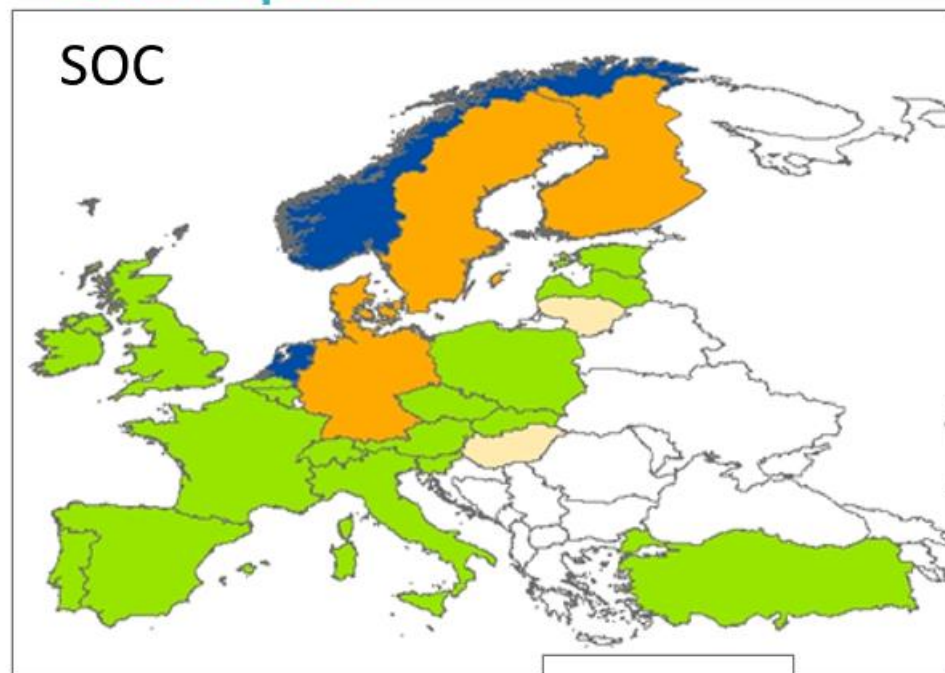
THE CONCEPT OF AUTHORITATIVE SOIL DATASETS

SOIL INFORMATION OFFICERS



D6.1- chapter 2 Diversity of methods - example

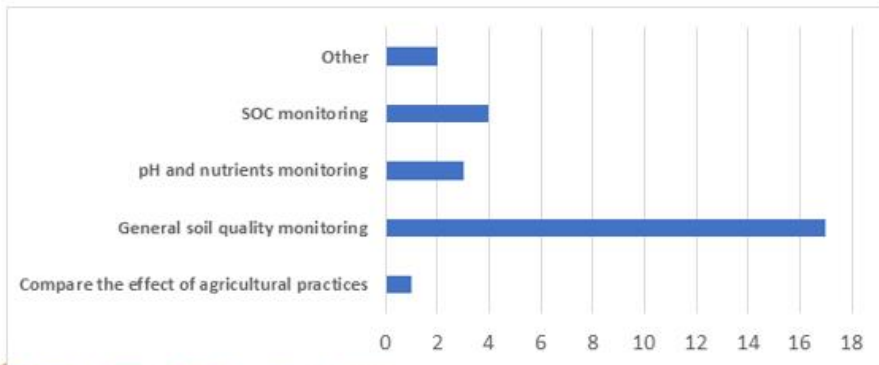
SP 1.3 Organic C				applied method					
Country	Relevant for topic	databases		WET_WB	WET_TYURIN	WET_OTHER	DRY_W_LOSS	DRY_ADC	other
		data policy	(at least a part of it) open access or freely available for EJP SOIL						
Austria	4	FPO	eBOD	yes	no	yes	no	yes	no
Belgium Flanders	2	F	DOV, SOCMB	yes	no	no	no	yes	no
Belgium Wallonia	3	P	-	yes	no	no	yes	yes	no
Czech Republic	3	PO	-	yes	no	yes	no	yes	no
Denmark	5	RP	DDSM	no	no	no	yes	yes	no
Estonia	3	FRO	KESE, SMI	no	yes	no	no	yes	no
Finland	2	P	-	no	no	no	no	yes	no
France	4	FP	RMQS, BDAT	no	no	yes	no	yes	no
Germany	1	F	BZE_LW	no	no	no	no	yes	no
Hungary	1	P	-	no	yes	no	no	no	no
Ireland	3	PO	-	yes	no	no	no	yes	no
Italy	5	FP	SISI, PPD, NS	yes	no	yes	no	yes	no
Latvia	7	RP	LLU	no	yes	no	no	yes	no
Lithuania	1	F	DR1OLT	no	yes	no	no	no	no
Netherlands	3	O	-	no	no	no	no	yes	yes
Norway	3	FP	NSS	no	no	no	no	yes	yes
Poland	4	FRP	MChGO, MonFrm	no	yes	no	no	yes	no
Portugal	4	FP	INFSOL, PROSOL	yes	no	yes	no	yes	no
Slovakia	2	P	-	yes	yes	no	no	yes	no
Slovenia	1	F	SPSLO	yes	no	no	no	no	no
Spain	5	P	-	yes	no	no	no	yes	no
Sweden	5	FP	SOILCOM	no	no	no	yes	yes	no
Switzerland	1	F	SWISOIL	yes	no	no	no	yes	no
Turkey	1	P	-	yes	no	yes	no	yes	no
United Kingdom	7	FRP	NSI_Top, NSISC88, NSISC09, AFBI 5K, TEL_XRF	yes	no	no	yes	yes	no
%*				52	24	24	16	88	8



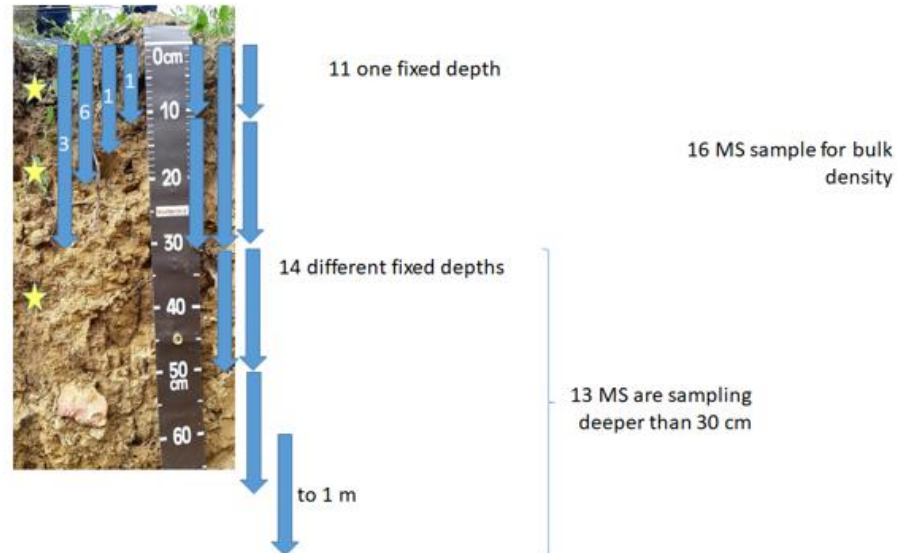
SURVEY OF NATIONAL SOIL MONITORING NETWORKS IN EJP SOIL COUNTRIES



4 according to horizons



- 21 countries answered out of 24 (ending with 28 declared SMS)
- Turkey and Portugal do not have SMS
- Five countries have 2 or 3 monitoring systems
 - SMS managed at regional scale
 - SMS with different purposes (e.g. agricultural vs forest, monitoring trace element vs agricultural parameters, monitoring a network of highly instrumented sites vs network agricultural soils)
- Caution: Not all countries declared their forest SMS



Convegno SoilHUB 28 Ottobre 2021

SMS with very diverse protocols and with different soil parameters monitored

Double sampling exercise - EJPSOIL support for the validation of transfer functions



Analytical procedures

- Double samples obtained from LUCAS 2022 samplers
- Between 100 and 200 sites will be analyzed depending on the countries
- 17 countries involved
- Comparison of EU and national results

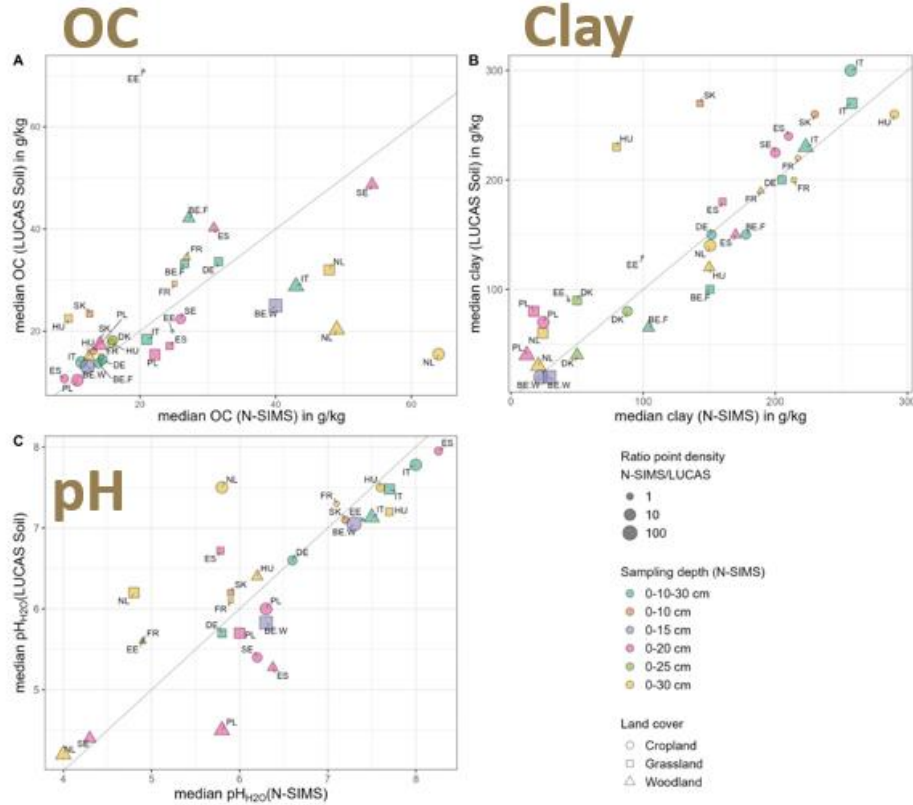


Sampling and analytical procedures

- Sampling (on national SMS and/or on LUCAS 2022 points) according to national and LUCAS sampling protocols
- 6 countries involved
- Compare the overall process

To be done: comparison of LUCAS and national soil datasets and development of transfer/intercomparison methods based on samples collected during LUCAS 2022 campaign

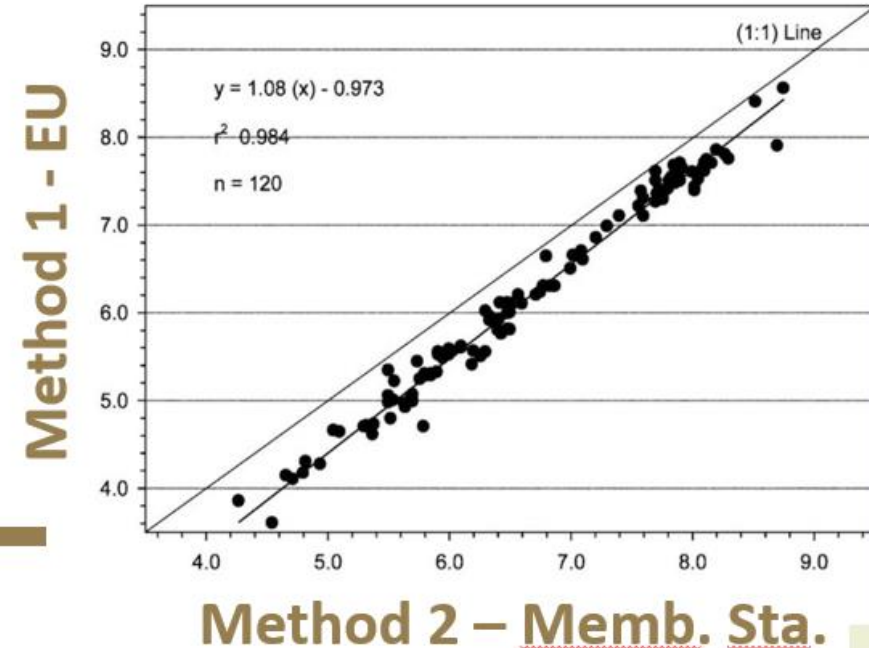
LUCAS dataset



National datasets

• Double sampling exercise done during LUCAS sampling in 2022

- LUCAS samples collected will be analysed by EU and by national labs
- Comparison of results will allow to develop transfer functions



ON THE STANDARDIZATION ON ANALYTICAL PROCEDURES AND QUALITY CHECK

There is the need to apply standard methods (ISO standards when available) and standard operating procedures.

Furthermore, certifying organisms for laboratories and ring testing to ~~an~~ <http://www.iso.org/iso/implementation> of ~~S~~ ed.



The screenshot shows the website for SILPA (Società Italiana Laboratori Pedologici e Agrochimici). The header includes navigation links: Home, Notizie, Statuto-scopi-organi, Laboratori SOCI SILPA, Ring Test, Documenti, Links, and Contatti. A 'NOTIZIE RECENTI' section lists recent news items. A 'CERCA NEL SITO' search bar is present. The main content area features a Vitruvian Man illustration with a rainbow, and text for S.I.L.P.A. (Società Italiana Laboratori Pedologici e Agrochimici) located at Via Alberoni, 17 - 48100 RAVENNA. Contact information includes telephone (0546-682763), fax (0546-665937), and email (malavolti@arpae.it).

In Europe and in the World



<https://www.fao.org/global-soil-partnership/glosolan/en/>



International Soil-analytical Exchange Programme – ISE (Wageningen University)

<https://www.wepal.nl/en/wepal/Home/Proficiency-tests/Soil/Proficiency-tests/ISE.htm>



Workflow, joint LUCAS and national Soil Information and Monitoring Systems (SIMS) to achieve the common maps

WP6
Task 6.3

Comparison of soil property data, available in both **LUCAS** and **SIMS** datasets based on common R-scripts (by INRAE):

- identification
- data conversion
- explanatory analysis
- spatial analysis, maps

WP6
Task 6.2

„preliminary concept”

AUXILIARY VARIABLES	POINT DATASETS	DSM METHOD
Common Stack EU-wide auxiliary variables (AVs) 1. EU-wide auxiliary variable 2. EU-wide auxiliary variable 3. EU-wide auxiliary variable	(WOSI+LUCAS) (WOSI+) LUCAS+national point data	(1.) DSM method: Quantile Regression Forest (2.) EU-wide mapping
4. EU-wide auxiliary variable n+1. EU-wide auxiliary variable	(The most predictive AVs at national level SELECTED from Stack) (WOSI+LUCAS+national point data)	(3.) DSM method: Quantile Regression Forest
Common Stack EU-wide AVs, partly substituted by national auxiliary variables 1. EU-wide AVs partially SUBSTITUTED by national AVs 2. EU-wide auxiliary variable 3. EU-wide AVs partially SUBSTITUTED by national AVs 4. EU-wide auxiliary variable n+1. EU-wide auxiliary variable	(WOSI+LUCAS+national point data) (WOSI+LUCAS+national point data)	(4.) Country-driven mapping for volunteers
		(5.) 2-steps mixed procedure for mapping (suggested by Thunen) a) each country selects the best inference model + b) the best EU inference model to handle transboundary effects

Research opportunities for volunteers

Acceptable result

EU-wide common auxiliary variable set and shared platform and guidance for mapping

refresh

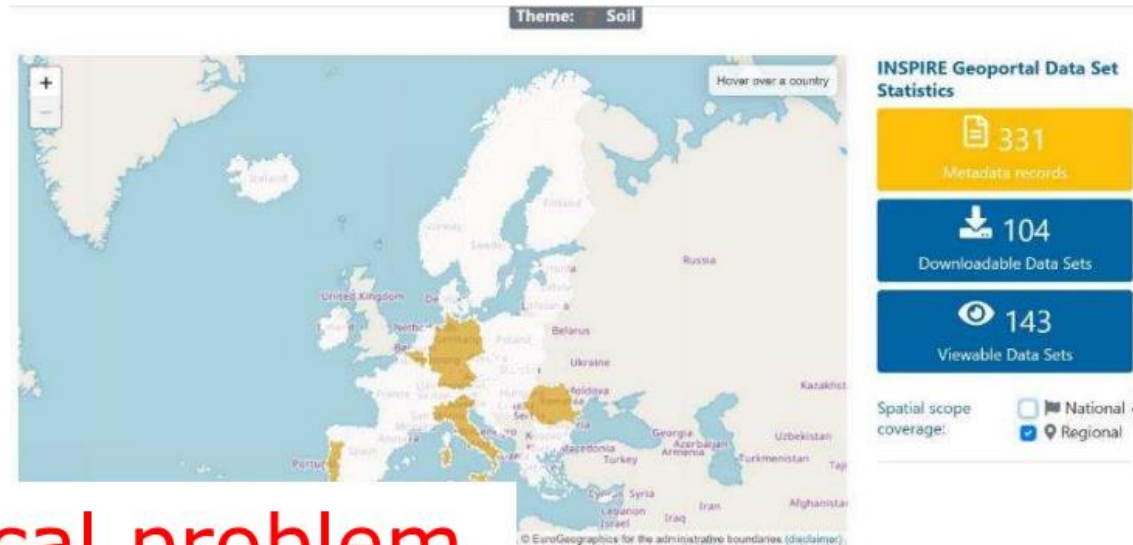
WP6
Task 6.3

Initialized LUCAS double sampling campaign to measure the same sample of soil parameters according to LUCAS and national methodologies

Expected results are (?after EJP): transfer functions

FUTURE

The INSPIRE geoportal, theme: Soil



Often also technical problem

Select a COUNTRY

Austria	9 8 9	Finland	0 0 0	Latvia	0 0 0
Belgium	0 0 0	France	0 0 0	Liechtenstein	0 0 0
Bulgaria	0 0 0	Germany	16 14 16	Lithuania	1 1 1
Croatia	1 0 0	Greece	0 0 0	Luxembourg	4 4 4
Cyprus	0 0 0	Hungary	0 0 0	Malta	1 1 1
Czech Republic	1 0 1	Iceland	0 0 0	Netherlands	4 4 0
Denmark	1 0 0	Ireland	0 0 0	Norway	2 0 0
Estonia	2 0 1	Italy	0 0 0	Poland	2 2 1

Select a COUNTRY

Austria	0 0 0	Finland	0 0 0	Latvia	0 0 0	Portugal	3 2 3
Belgium	21 21 21	France	0 0 0	Liechtenstein	0 0 0	Romania	1 0 0
Bulgaria	0 0 0	Germany	131 33 108	Lithuania	0 0 0	Slovakia	0 0 0
Croatia	0 0 0	Greece	0 0 0	Luxembourg	0 0 0	Slovenia	0 0 0
Cyprus	0 0 0	Hungary	0 0 0	Malta	0 0 0	Spain	0 0 0
Czech Republic	0 0 0	Iceland	0 0 0	Netherlands	0 0 0	Sweden	0 0 0
Denmark	0 0 0	Ireland	0 0 0	Norway	0 0 0	Switzerland	0 0 0
Estonia	0 0 0	Italy	175 48 11	Poland	0 0 0		

Very few soil data uploaded in the INSPIRE geoportal for the theme soil. The majority of EJP SOIL partners have national/sub-national geoportals, but not all. The information uploaded is not standardised/harmonised.

Datasets

The European Soil Data Centre (ESDAC) contains currently many soil data and information; most of the offered data are at European scale, while, when possible, links to national or global datasets are provided.

Datasets are organized in some broad categories.

- A first category contains the European Soil Database (ESDB), datasets that have been derived with the help of the ESDB and general European datasets that contain soil properties.
- A second category offers data that are related to soil threats (erosion, soil organic carbon, landslides, compaction, salinization, soil biodiversity, contaminated sites, soil sealing, etc.)
- A third category offers soil point data (LUCAS, SPADE, etc)
- A fourth category contains data that stem from projects.

ESDAC:

- One-stop hub for soil data at EU-scale with a long-term commitment by JRC (since 2006)
- Providing EU and European-wide datasets, associated documentation
- Active helpdesk, wide audience

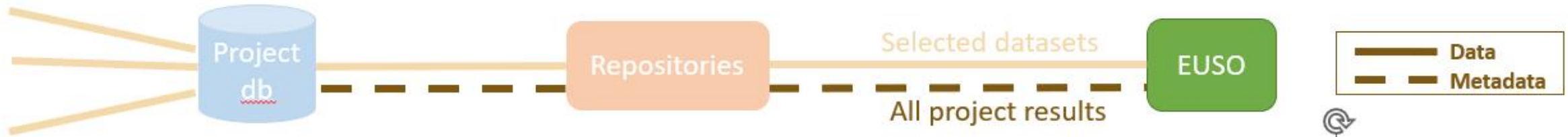
EUSO:

- To provide a dynamic and inclusive platform that supports EU soil-related policymaking
- Provide the Commission and broader soil user community with knowledge and data flows on soils
- Includes Stakeholder Forum and a EUSO data integration working group, chair: JRC, Marc Van Liedekerke



Registration requested: [Request Form](#)

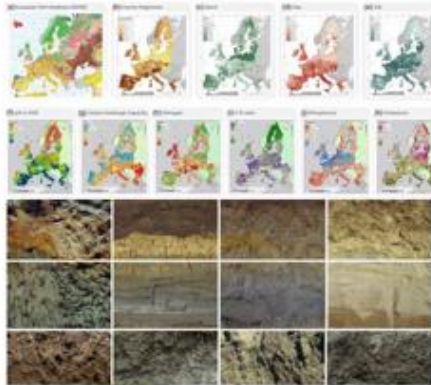
1) MAKE DATA FINDABLE =>> upload in online metadata catalogues



About EJP SOIL ▾ Research ▾ Science to policy Knowledge Sharing Platform ▾ GM & Annual Science Days ▾

EJP SOIL > Research > Soil data & Monitoring, mapping and modelling

Soil data & Monitoring, mapping and modelling



Search the Soil data catalogue system

The soil data catalogue is a user friendly search experience.

The catalogue contains:

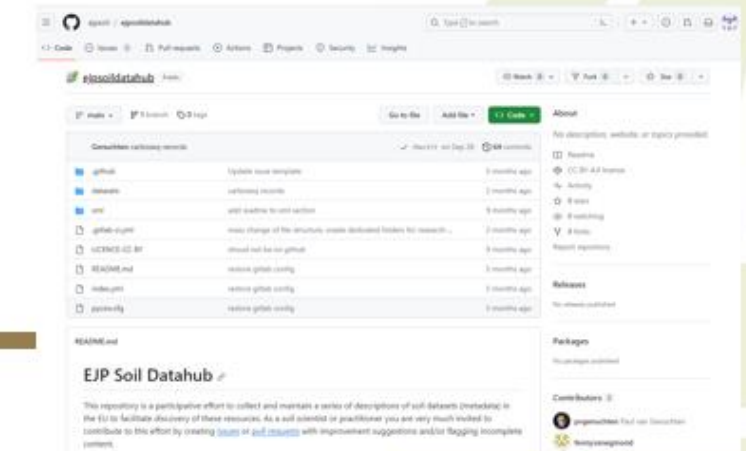
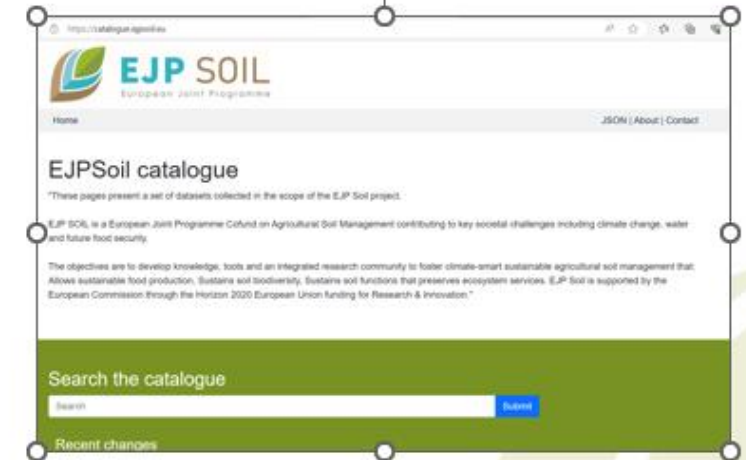
- Data products produced in the EJP SOIL and in the wider Soil community
- An overview of national datasets

Visit the csoil data catalogue via one of the following two points of access:

- The searchable interface: <https://catalogue.ejpsoil.eu>
- A GIT repository [GitHub - ejpsoil/ejpsoildatahub](https://github.com/ejpsoil/ejpsoildatahub) (The source of the metadata).

An aspect of the catalogue system is a minimal metadata template in Excel, developed to provide a minimalistic approach to bulk loading records into the catalogue. Alternative available bulk loading initiatives are importing from CSV and DOI (harvesting).

In case you identify potential improvements, create an issue on the git repository or submit an improvement.





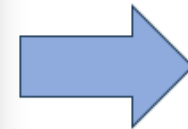
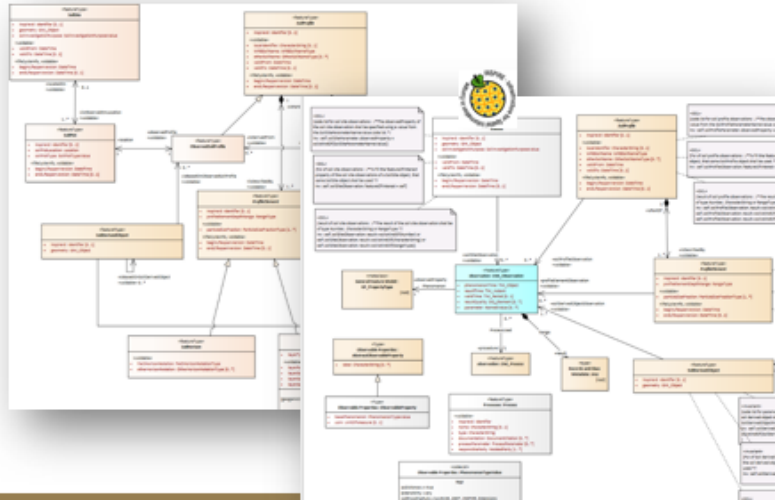
Software framework for a shared agricultural soil information system – Deliverable 6.4



Focus on:

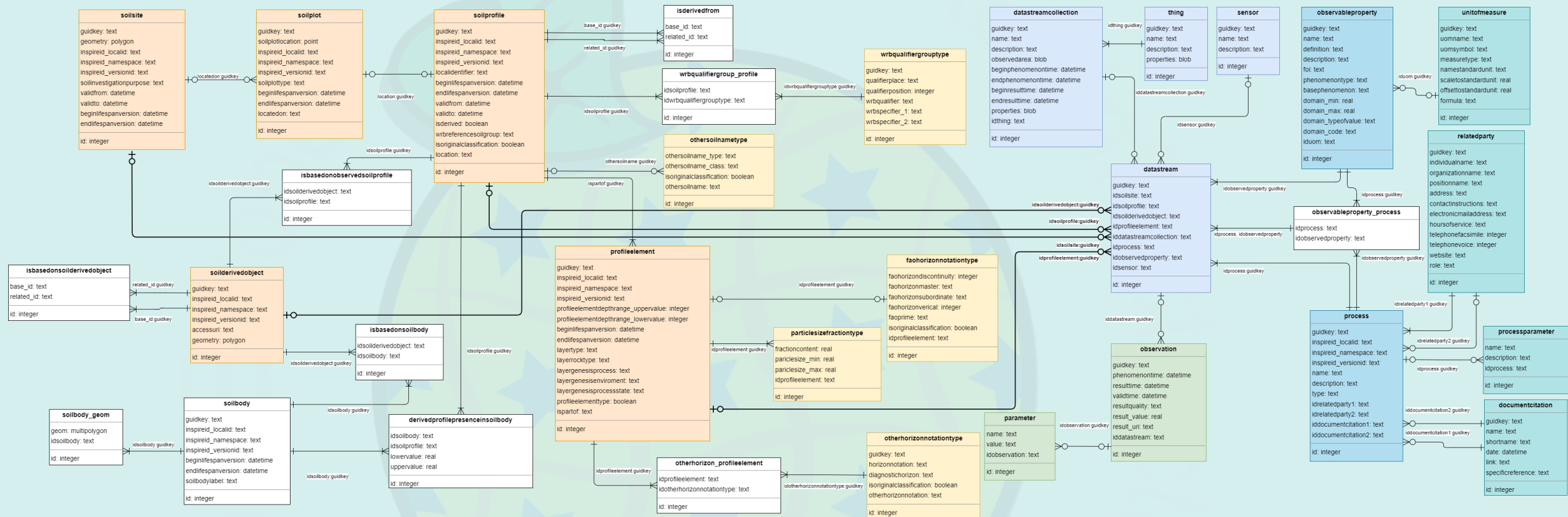
- cross-border data sharing
- simplified and more usable (INSPIRE) deliveries
- operational efficiency and ease of use

**Facilitate
harmonised
soil data
exchange**



- Lightweight
- Performant in GIS environments
- Efficient with limited connectivity and bandwidth

THE D6.4 GEOPACKAGE relational model INSPIRE compliant

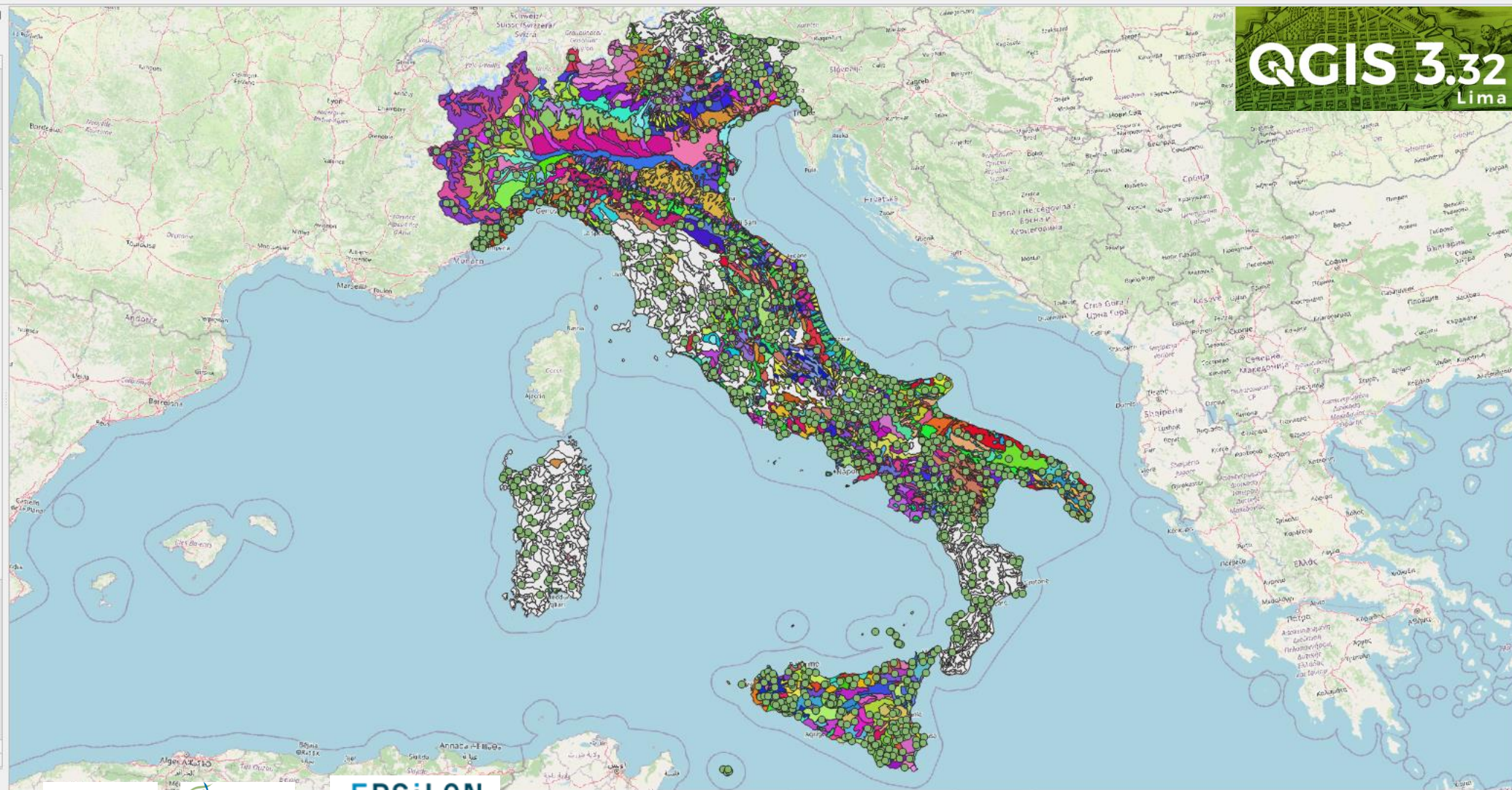


From INSPIRE UML to INSPIRE GPKG



Browser

- Vector-hale.10oct23.gpkg
- Vector.gpkg
 - codelist
 - Demo
 - derivedprofilepresenceinsoilbody
 - faehorizonnotationtype
 - isbasedonobservedsoilprofile
 - isbasedonsoilbody
 - isbasedonsoilderivedobject
 - isderivedfrom
 - otherhorizonnotationtype
 - othersoilnametype
 - particlesizefractiontype
 - profileelement
 - soilbody
 - soilbody_geom
 - soilbody_sicily
 - soilderivedobject
 - soilplot
 - soilprofile
 - soilsite
 - wrbqualifierrgroupuype
 - Relationships
 - profileelement_faehorizonnotationtype
 - profileelement_otherhorizonnotationtype
 - profileelement_particlesizefractiontype
 - soilbody_derivedprofilepresenceinsoilbody_2
 - soilbody_isbasedonsoilbody
 - soilbody_soilbody_geom
 - soilbody_soilbody_sicily
 - soilderivedobject_isbasedonobservedsoilprofile_2
 - soilderivedobject_isbasedonsoilbody_2
 - soilderivedobject_isbasedonsoilderivedobject
 - soilderivedobject_isbasedonsoilderivedobject_2
 - soilplot_soilprofile
 - soilprofile_derivedprofilepresenceinsoilbody
 - soilprofile_isbasedonobservedsoilprofile
 - soilprofile_isderivedfrom
 - soilprofile_isderivedfrom_2
 - soilprofile_othersoilnametype



Layers Browser Processing Toolbox

Type to locate (Ctrl+K)



successfully VALIDATED in the INSPIRE validator

Search options

Resource type

Status

Refine results

Clear all

Show All Test Reports



Test run on 15:47 - 15.01.2024 with test suite Annex III - Soil (SO)

Started 3:47 PM - 15.01.2024

Status PASSED_MANUAL


Test object <http://staging-inspire-validator.eu-west-1.elasticbeanstalk.com/validator/v2/TestRuns/EIDd72a984c-4386-41c2-9954-23c811234426.xml>


Test suites


- Conformance Class INSPIRE GML encoding
- Conformance Class Reference systems
- EID6f90ab57-9b10-4f67-859a-fd62d75f32c2
- Conformance Class Information accessibility
- EID28051c99-ff98-480c-b8c1-b502333cc3cd
- Conformance Class Data consistency
- EID480f945a-d0c8-4582-a1fe-775cea3d1f48
- Conformance Class INSPIRE GML application schemas
- EID31880338-6fe3-486c-8f3e-7086a20490c4
- EID09b2bdfc-54fd-4884-b9bd-59f18dff358b

See report 

Log file 

Download report 

Delete report 

Re-run test 

INSPIRE model transformation rules

encoding-agnostic rules that can be applied to the INSPIRE UML data models to derive models more fit for certain use cases e.g., for alternative encodings

Catalogue of model transformations rules [↗](#)

This catalogue contains general model simplification rules identified so far. The catalogue also contains several substitution rules, where existing types are replaced with less complex types.

Identifier	Name	Category
MT001	Flattening of Nested Structures	simplification rule
MT002	Extract Primitive Arrays	simplification rule
MT003	Flatten Associated Components using Typenames	simplification rule
MT004	Flatten Associated Components using Codelist Values	simplification rule
MT005	Simple Geographic Name	substitution rule
MT006	Refer to Property Values by Reference	simplification rule
MT007	Simple Citation	substitution rule
MT008	Simple Codelist Reference	substitution rule
MT009	Simple Period	substitution rule
MT010	European Legislation Identifier	substitution rule

Implementation example for the SOIL data theme

INSPIRE GeoPackage Good Practice

gp-geopackage-encodings / examples / overview.md ↑ Top

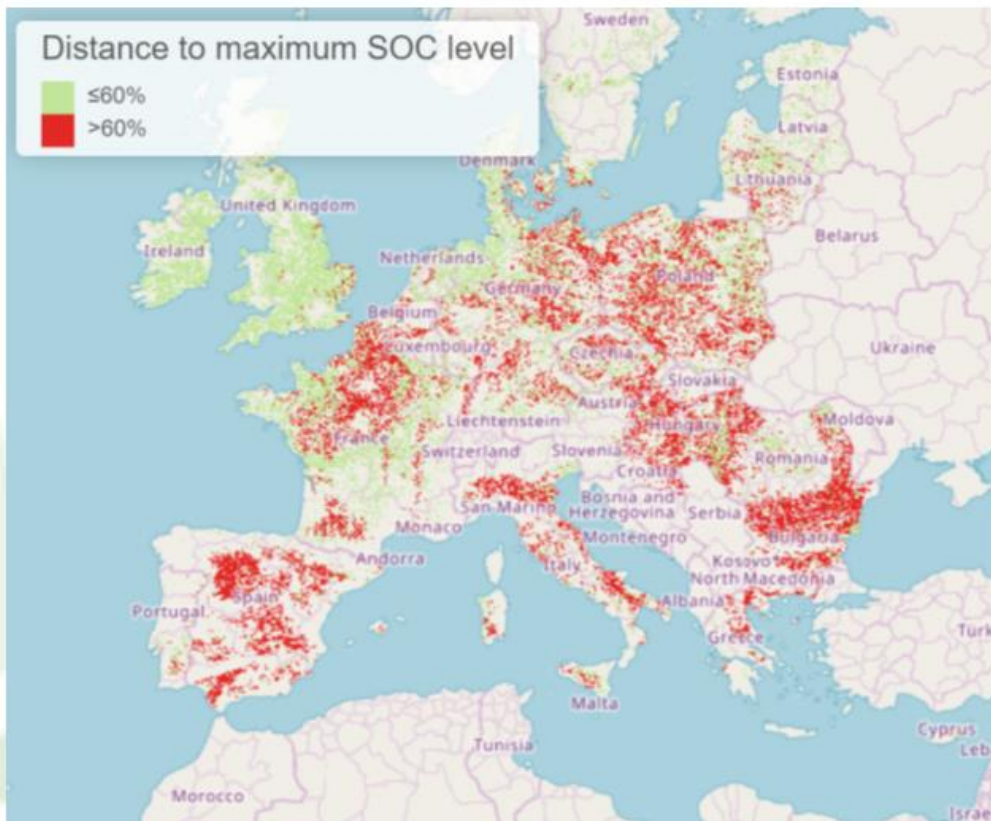
Preview Code Blame 55 lines (52 loc) · 7.11 KB Raw ↗ ↕ ⬇

IT	Geology	Go-PEG project "Go-Depth use-case", ISPRA - Geological Survey of Italy has developed an efficient approach to manage and deliver interoperable subsurface geological data using an INSPIRE-extended data model and geopackage INSPIRE alternative encoding. This approach fulfills the institutional mandates of the Geological Survey of Italy and will be the starting point for the ongoing design and implementation of the "Geological 3D subsurface models database" related to the National Geological Mapping Programme. Moreover, the model could be tested in EU initiatives (e.g. EPOS, Geological Mapping and Modeling Expert Group of EuroGeoSurveys) and furtherly implemented and extended in projects funded by NextGeneration EU national plan. The produced dataset related to Po Plain subsurface can be downloaded at https://www.epsilon-italia.it/public/GO-PEG/Po_Basin_subsurface.gpkg . The related geopackage template can be downloaded at https://www.epsilon-italia.it/public/GO-PEG/go-depth-ge-template.gpkg
EJPSOIL	Soil	In the context of the H2020 European Joint Research Programme EJPSOIL and in particular in the creation of a 'Software framework for a common agricultural soil information system', a GeoPackage model has been developed by CREA (Council for Agricultural Research and Economics of Italy) which is proposed as a specific implementation for the Soil data theme of the GP on GeoPackage encoding of INSPIRE datasets. As required by the GP specification, the following evidence has been provided: 1)a description of the UML-to-Geopackage model transformation rules 2)an empty geopackage template acting as database schema (also provided via SQL scripts) 3)an executable model for data transformation of GeoPackage datasets into INSPIRE GML datasets. Specifically, this executable model is provided in the form of a hale studio project. 4)a sample GML dataset through the above-mentioned data transformation project, containing spatial objects and related observations and successfully validated against INSPIRE Soil requirements using the INSPIRE Validator. For the observation and measurement data, the transposition of the OGC SensorThings API has been utilized.



validate (sample) soil GMLs derived from related GPKG

Soil Health Monitoring – EUSO Dashboard and the SoilWise project



<https://esdac.jrc.ec.europa.eu/esdacviewer/euso-dashboard/>

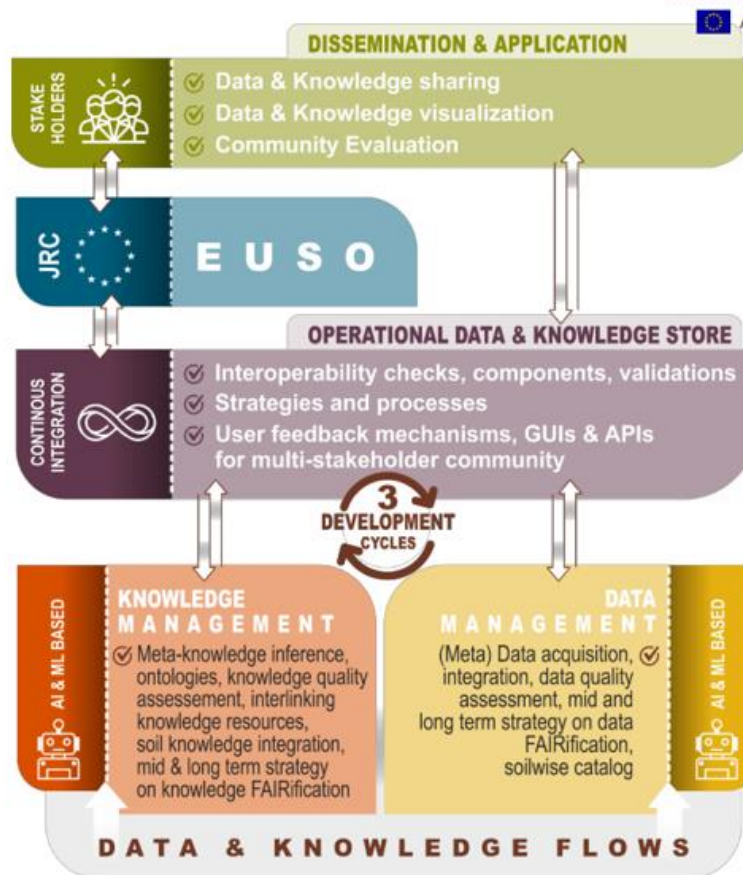


Figure 1 Overview of SoilWise methodological approach.

<https://soilwise-he.eu/>



SEE YOU AT THE

Breakout session 5: Harmonising public and private data for monitoring soil carbon dynamics.

maria.fantappie@crea.gov.it