Towards 100m resolution soil property maps for European Forest soils

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ISRIC – World Soil Information

(WDC-Soils)









- Summary of work relating to the development of a set of standardised/harmonised point data to support modelling work within HoliSoils project
- This activity builds on procedures developed for the WoSIS and GloSIS databases
- Present focus on procedures for ingesting, screening/cleaning, standardising, and harmonising soil data obtained from disparate sources

 \circ Next steps



<u>WoSIS</u>: World Soil Information Service (ISRIC) <u>GloSIS</u>: Global Soil Information System (GSP)

Main steps: Data collation, harmonisation, and mapping







T3.5: 100m x100m resolution soil property maps for forest soils in Europe

T3.6: Mmaps served via Thuenen Geonode (TISDAR)

Datasets received by April 2022



- Forest soil data for Europe were collated by T3.3.
- This activity resulted in \sim 8,800 profiles, with various license constraints.
- These are to represent \sim 227 million ha forest soils (\sim 3.8 points / 1000 km²).

Dataset	License	X,Y accuracy ^a	No of sites
ICPF Level II	CC-BY (sg)	± 1km	~ 700
CPF Level I-S1	CC-BY (sg ^b)	± 1km	~ 5600
RMQS France	CC-BY (sg)	± 1km	~ 2000
Poland	CC-BY (ws)	\checkmark	~ 500

 Hence need to consolidate the 'HoliSoils' set with ISRIC WDC-Soils holdings (WoSIS) for similar 'agro-climatic' conditions and time intervals.

^a For some countries, more detailed coordinates were provided.

^b Some data (sg) can only be used for mapping at ISRIC WDC-Soils (i.e. coordinates of point data may not be shown)

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• Data providers have two options for sharing their data:

A) The standardised data are made *freely available* to the international community (i.e. geo-locations may be shown; distributed via 'wosis-latest' or as a 'holisoils-subset').

B) The standardised data themselves are *NOT made available* to the international community (e.g. geo-locations may not be shown). They can only be used for producing SoilGrids and similar products. In this case, only the 'derived map products' can be made *freely available* to the international community.

Note: Source data in ISRIC repository are not shared (i.e. only safeguarded as is)





Data ingestion, standardisation and harmonisation

- Basic quality/consistency control
- Identify repeated profiles
- Standardise attribute names
- Standardise analytical method descriptions
- Standardise units (incl. conversion factors)
- Plausibility checks (min, max, mean)

Soil observations and measurements (**O&M**):

- Feature (georeferenced profiles & layers; x, y, z and time)
- Attributes: layer-field (**O**) or layer-lab (**M**)
- Method: value (and units of expression) resp. classes Lineage:
- Datasets, reports & maps
- License

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Key properties desired for HoliSoils mapping, based on initial WP consultations



- Organic versus mineral soil layer
- Bulk density
- Carbon (Total & Organic)
- Calcium carbonate
- Cation exchange capacity
- Total Nitrogen
- Electrical conductivity (Ec_x, Ec_{sat})
- pH (H₂O, KCI, CaCl₂, NaF)
- ⁷Coarse fragments
- Texture (sand, silt, clay)
- Water retention (at specified tensions)
- Available P (specified methods)

Also:

- Classification: FAO (year, WRB (year), USDA Soil Taxonomy (year), as provided
- Horizon designation (as provided, cleaned only)

^{*} Based on 'operational definitions'; for each property, the analytical procedures should be documented in the metadata of the source datasets





Characterising different soil analytical methods according to key criteria (example pH-KCI)

Procedure									
Key	ISO ⁵	ISRIC ⁶	USDA ⁷	WEPAL ⁸	GLOSOLAN				
Pretreatment	<2 mm	<2 mm	<2 mm	<2 mm	<2 mm				
Solution	KCI	KCI	KCI	KCI	KCL				
Concentration	1 M	1 M	1 M	1 M	1 M				
Ratio	1:5	1:2.5	1:1	1:5	1:5				
Ratio base	V/V	w/v	w/v	V/V	w/v				
Instrument	Electrode	Electrode	Electrode	Electrode	Electrode				

* Methods are based on 'operational definitions' (USDA, 2011)

WoSIS Procedures Manual (2020)



Harmonise source method X to reference method Y



- Make the data comparable, as if assessed by a single given (reference) method (Y)
- ICPF methods used as reference methods (ISO Soil Quality protocols)
- To develop 'harmonisation' rules/functions need to have:

 a) access to results of proficiency testing (PT) programmes in which the same soil samples were analysed according to various 'national' standards (X) as well as the selected standard method Y.
 or:

b) find possible pedotransfer functions from the literature.

However, 'there is generally no universal equation for converting from one method to another in all situations: need to develop locally relevant PTFs at the node/national level' (GlobalSoilMap, 2015).

Examples of PTFs for harmonising values of organic carbon to a reference standard



No.	Target Method Y	= Source Method X	* Slope	+ Intercept	R2	Reference	
1	Dry Combustion	Spectro-photonic	0.9800	0.0000	0.98	Soon and Abboud (1991)	
2	Dry Combustion	Walkley-Black	1.0500	0.0000	0.98	Soon and Abboud (1991)	
3	Dry Combustion	modified Tinsley	1.0400	0.0000	0.98	Soon and Abboud (1991)	
4	Dry Combustion	modified Mebius	1.4000	0.0000	0.99	Soon and Abboud (1991)	
5	Dry Combustion	Loss on Ignition (LOI)	0.6330	-9.3600	0.98	Soon and Abboud (1991)	
6	Tinsley (1950)	LOI at 850 C	0.4620	-1.3600	0.99	Ball. 1964	
7	Tinsley (1950)	To develop region-specific PTFs, need access to results of comparative					
8	Tinsley (1950)	analyses (e.g. WEPAL, GSP-GLOSOLAN). Generally, these are not freely					
9	DC (Leico at 875	available					
10	DC (Leico at 875	 LUCAS 2022 are in the proc 	ess of c	loing a doι	uble s	ampling exercise to	
11	DC (Leico at 875	develop transfer functions between national and LUCAS-EU methods (with					
12	DC (Leico at 875	focus on agricultural land).					
13	DC (Leico at 875	 Applications of PTFs will add 	d additic	nal uncert	ainty	to the original	
14	DC (Dumas at 10	measurement data: these er	ror sour	ces need	to be	considered (Van	
15	LOI at 550	Leeuwen et al., in prep.)					
16	LOI at 550	LOI at 450	0.9970	0.5000	0.98	Grewal et al., 1991	

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Generating soil property maps for HoliSoils







- Q2-2022: Refactoring data model ; ingestion/processing of 'HoliSoils' data sets (9 K profiles).
- Complement HoliSoils data acquisitions with holdings representing similar 'agroecological' regions and time intervals from WoSIS itself.
- Q3-2022: Generate set of 'harmonized soil property data' for the subsequent digital soil mapping work.
- Q4-2022: Develop/test procedures for producing 100m resolution soil property maps for Forest soils in Europe (with uncertainty) that consider positional accuracy (T3.5).
- Q1-2023: Compare HoliSoils SOC maps with similar products (in synergy with EJP Soil, ESP, ESA WorldSoils).
- Thereafter, deliver quality-assessed dataset/maps for serving/use via Thuenen GeoNode (TISDAR; T3.6)



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