ISRIC World Soil Information

World Data Center for Soils WDC Wageningen

Towards efficient workflows for soil data standardisation and model integration

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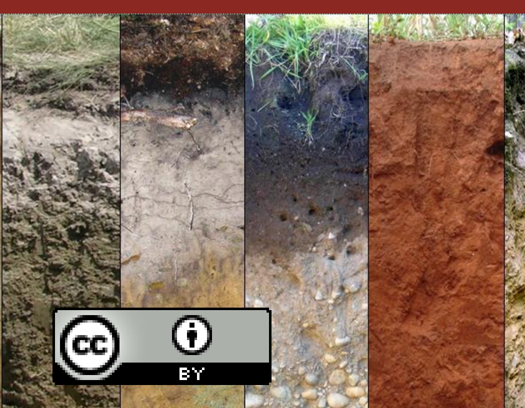
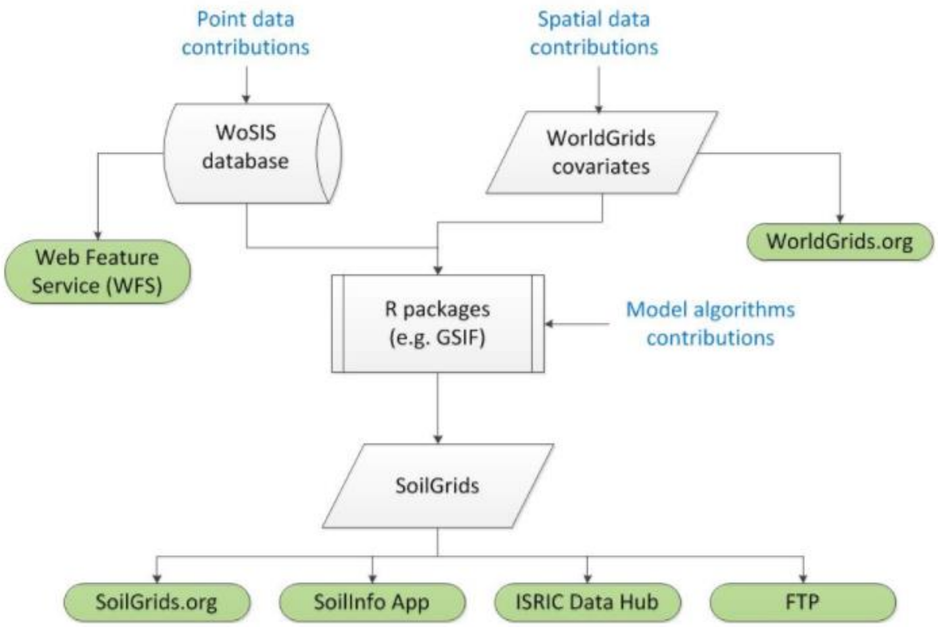
BONARES Conference (26 - 28 February 2018, Berlin)

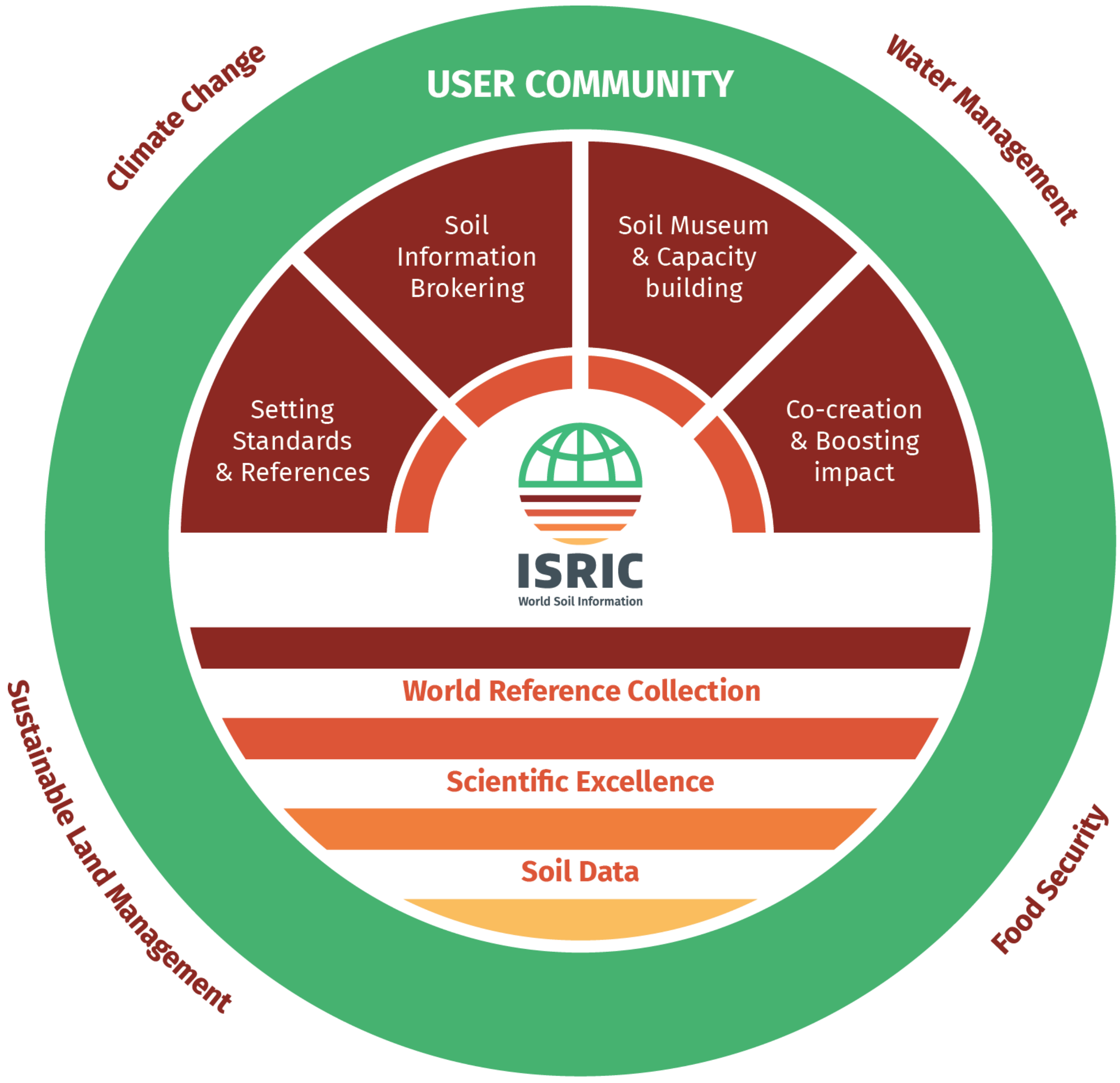


Roadmap

- ISRIC mission
- Standardising/harmonising soil profile data
- Automated production of soil property maps
- Use of quality-assessed soil information
- Spatial data infrastructu
  and inter-operability
- Concluding remarks



Simplified representation of ISRIC's workflow & Spatial Data Infrastructure


Climate Change
USER COMMUNITY
Water Management
Soil Information Brokering
Soil Museum & Capacity building
Setting Standards & References
Co-creation & Boosting impact
ISRIC
World Soil Information
World Reference Collection
Scientific Excellence
Soil Data
Sustainable Land Management
Food Security

User needs vary at different scales

<u>Scale</u>

1: 5,000,000

↓

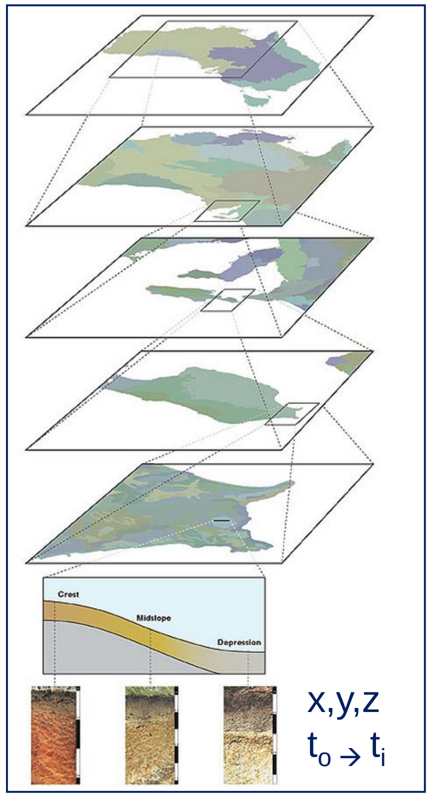
1: 250,000

↓

1: 5,000

↓

1:1



Global assessments

Regional studies

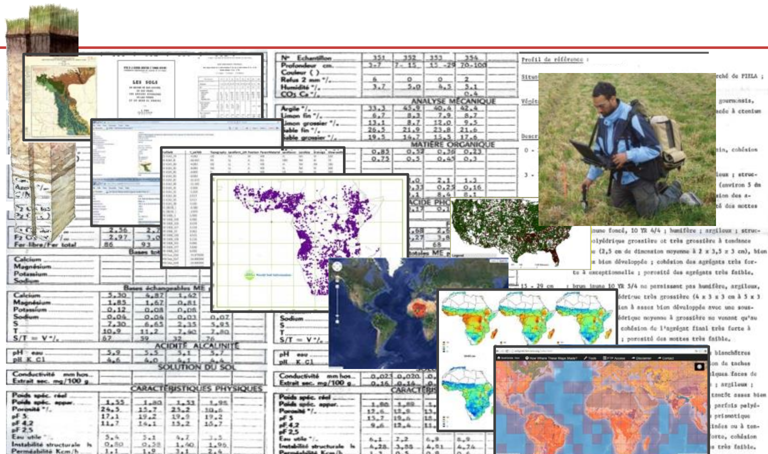
National studies

Spatial planning / Precision farming

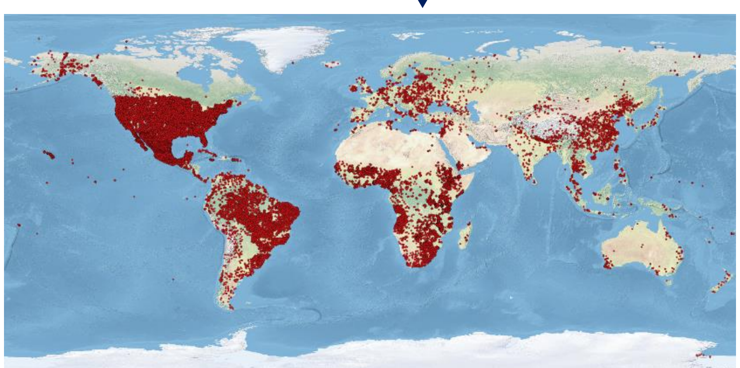
Soil monitoring

'There is no magic single resolution that serves all purposes'
(HarvestChoice, 2011)

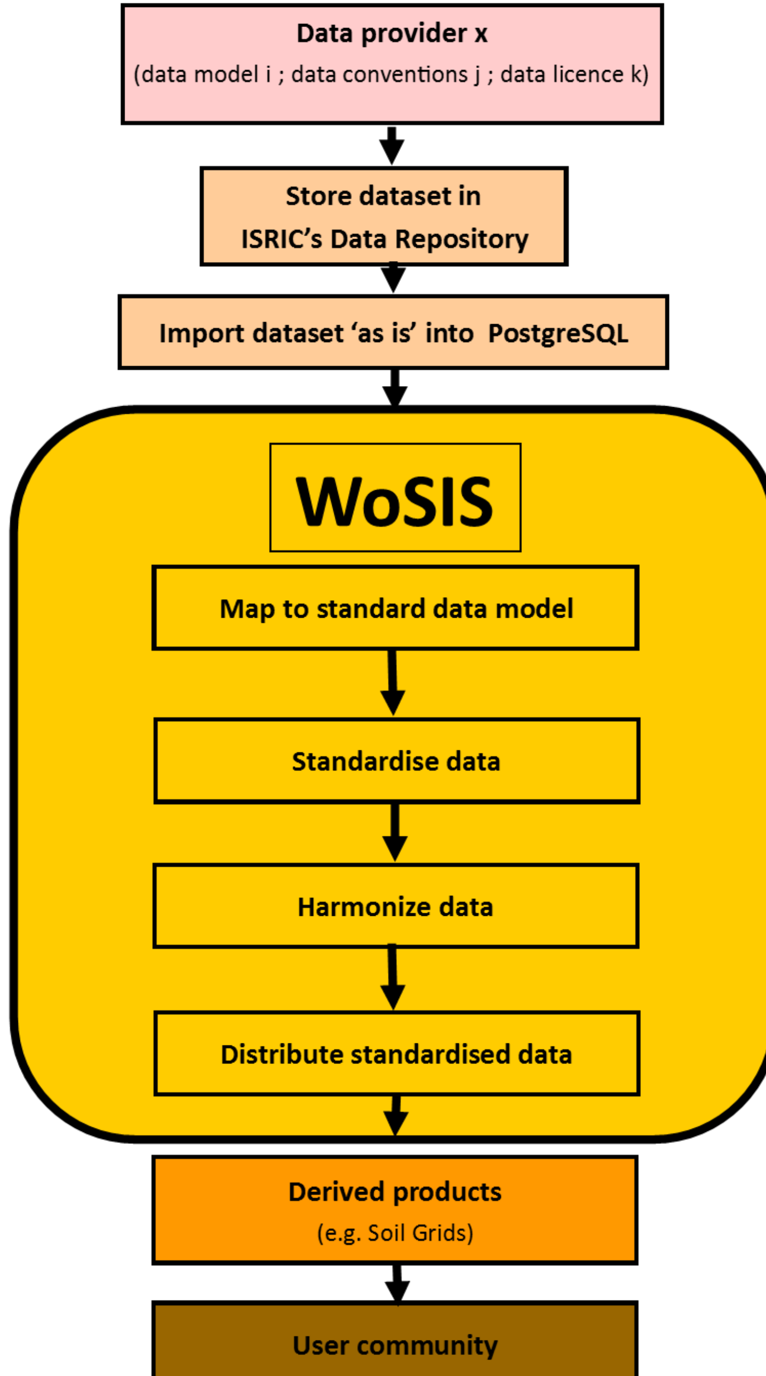
Workflow for serving quality assessed world soil data



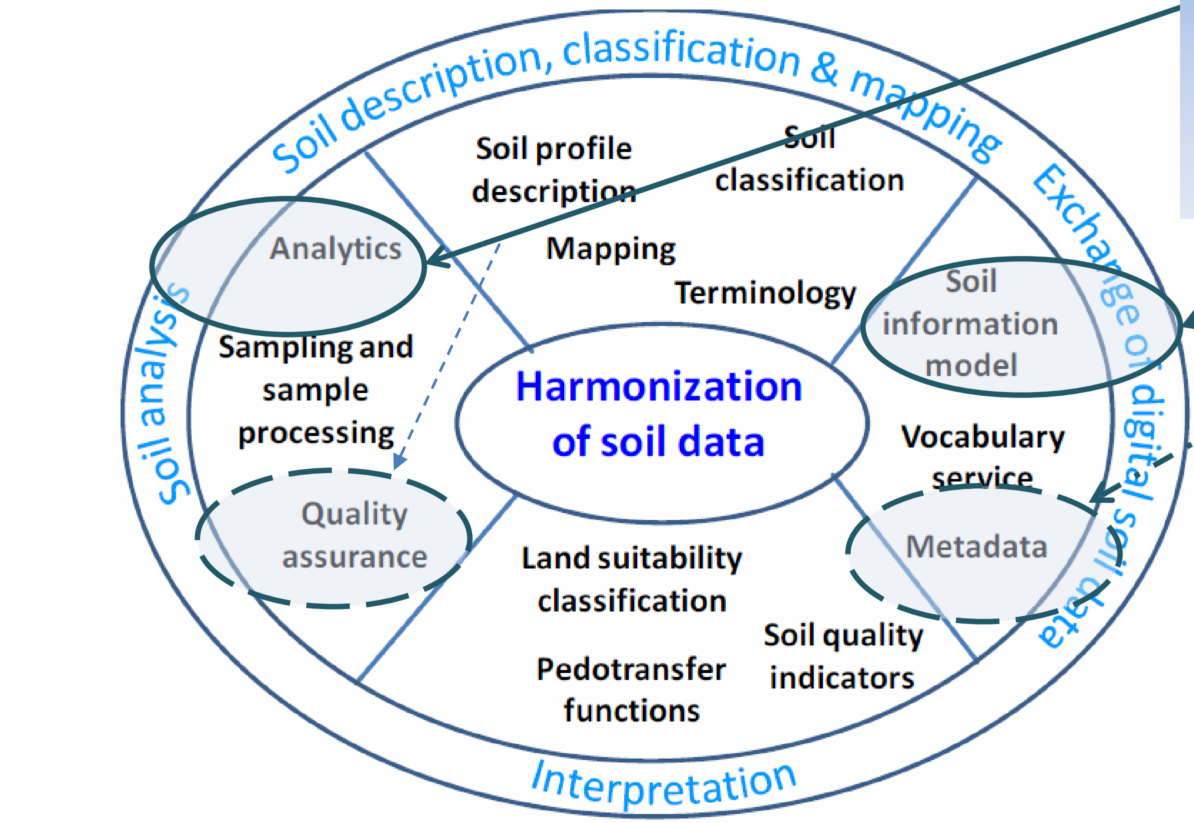
data licence



http://www.isric.org/projects/data-wosis-project



Key areas of harmonization



Present focus in WoSIS
(data derived from conventional soil survey; spectral data later)

"Providing mechanisms for the collation, analysis and exchange of consistent and comparable global soil data and information"
([GSP Pillar V])

Main standardisation steps

- Basic quality control
- Identify repeated profiles
- Attribute names
- Units (incl. conversion factors)
- Measured values
- Analytical method descriptions.

*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, including units of expression

Lineage:
- Datasets, reports & maps

Current focus: *GlobalSoilMap* specifications
pH
Organic carbon
CEC
Bulk Density
Water Holding Capacity [b]
Calcium carbonate equivalent
Sand, silt, clay fractions
Coarse fragments (>2mm; as volume percent of whole soil)
Electrical conductivity

http://www.globalsoilmap.net/specifications

Standardise analytical method descriptions

- Characterise major components of commonly used analytical methods for measuring a given soil property
- Criteria and coding steps are shown in flowcharts

	Procedure			
Key	*ISO*[5]	*ISRIC*[6]	*USDA*[7]	*WEPAL*[8]
Pretreatment	<2 mm	<2 mm	<2 mm	<2 mm
Solution	KCl	KCl	KCl	KCl
Concentration	1 M	1 M	1 M	1 M
Ratio	1 : 5	1 : 2.5	1 : 1	1 : 5
Ratio base	v/v	w/v	w/v	v/v
Instrument	Electrode	Electrode	Electrode	Electrode

-

Harmonise to reference method 'Y'

- Make the data comparable, as if assessed by a single given (reference) method 'Y'.
- No universal equation for converting from one method to another.
- Need 'region-specific' conversions to a given reference method Y, building on comparative analyses of reference soil samples (GSP WG5; GLOSOLAN).

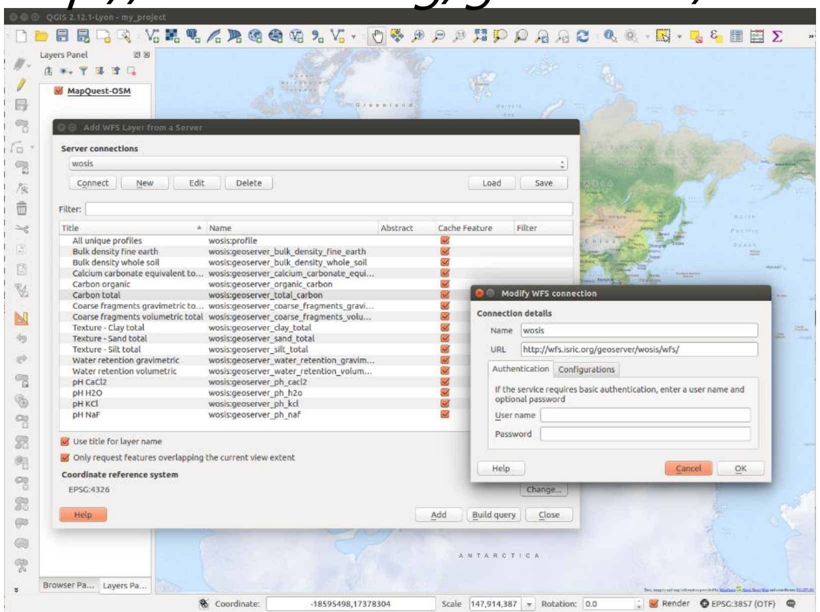
Example regression functions for converting values of pH between different methods

No.	Target Method (Y)	Source Method (X)	Equation	R2	Reference
1	pH (1:1 0.01 m CaCl2)	pH (1:1 water)	$y = 1.08(x) - 0.973$	0.98	Miller and Kissel (2010)
2	pH (1:1 0.01 m CaCl2)	pH (saturated paste)	$y = 1.10(x) - 0.923$	0.98	Miller and Kissel (2010)
3	pH (1:1 0.01 m CaCl2)	pH (1:2 water)	$y = 1.05(x) - 0.950$	0.97	Miller and Kissel (2010)
4	pH (1:1 water)	pH (1:1 0.01 m CaCl2)	$y = x + 0.267\,(\text{EC 1:1 water})^{-0.445}$	0.99	Miller and Kissel (2010)
5	pH (1:2 water)	pH (1:1 0.01 m CaCl2)	$y = x + 0.239\,(\text{EC 1:1 water})^{-0.505}$	0.98	Miller and Kissel (2010)
6	pH (1:5 0.01 m CaCl2)	pH (1:5 water)	$y = 1.012(x) - 0.76$	0.99	Conyers and Davey (1988)
7	pH (1:5 0.01 m CaCl2)	pH (1:5 water)	$y = 0.979(x) - 0.71$	0.68	Bruce et al., (1989)
8	pH (1:5 0.01 m CaCl2)	pH (1:5 water)	$y = 0.887(x) - 0.199$	0.88	Aitken and Moody (1991)
9	pH (1:5 0.01 m CaCl2)	pH (1:5 water)	$y = 0.197(x)^2 - 1.21(x) + 5.78$	[illegible]	[illegible]
10	pH (1:5 0.002 m CaCl2)	pH (1:5 water)	$y = 0.948(x) - 0.308$	[illegible]	[illegible]

Source: GlobalSoilMap

Serve the standardised data

- ***WFS (dynamic):*** *http://data.isric.org/geoserver/wosis_latest/wfs*



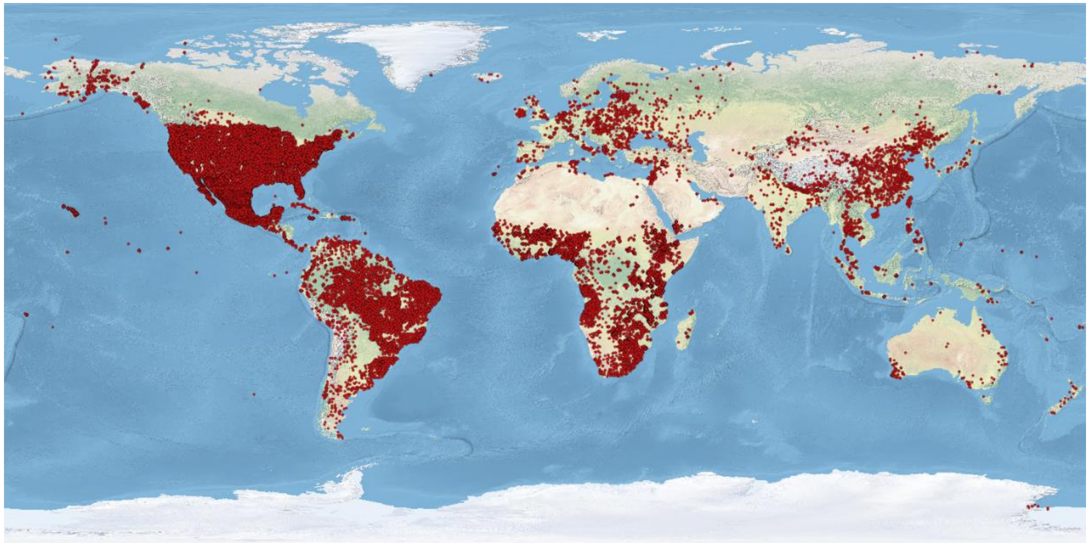
- ***CSV (snapshot):*** *[Earth Syst. Sci Data 9, 1-14](https://doi.org/10.5194/essd-9-1-2017)*

Earth Syst. Sci. Data, 9, 1-14, 2017
https://doi.org/10.5194/essd-9-1-2017

Article

WoSIS: providing standardised soil profile data for the world

Distribution of profiles (WoSIS, Feb. 2018)



x, y, z & t

Normalised and *structurally sound* data model serving:

- ~**110 thousand** geo-referenced profiles; corresponds with ~**30M** soil records of which **~4M** have been standardised so far**:**
  - Bulk density
  - Calcium carbonate
  - Carbon (Total & Organic)
  - Cation exchange capacity
  - Coarse fragments
  - Electrical conductivity
  - pH
  - Water retention
  - Texture (Sand, Silt, Clay)
  - Total Nitrogen
  - Available P (different methods)

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

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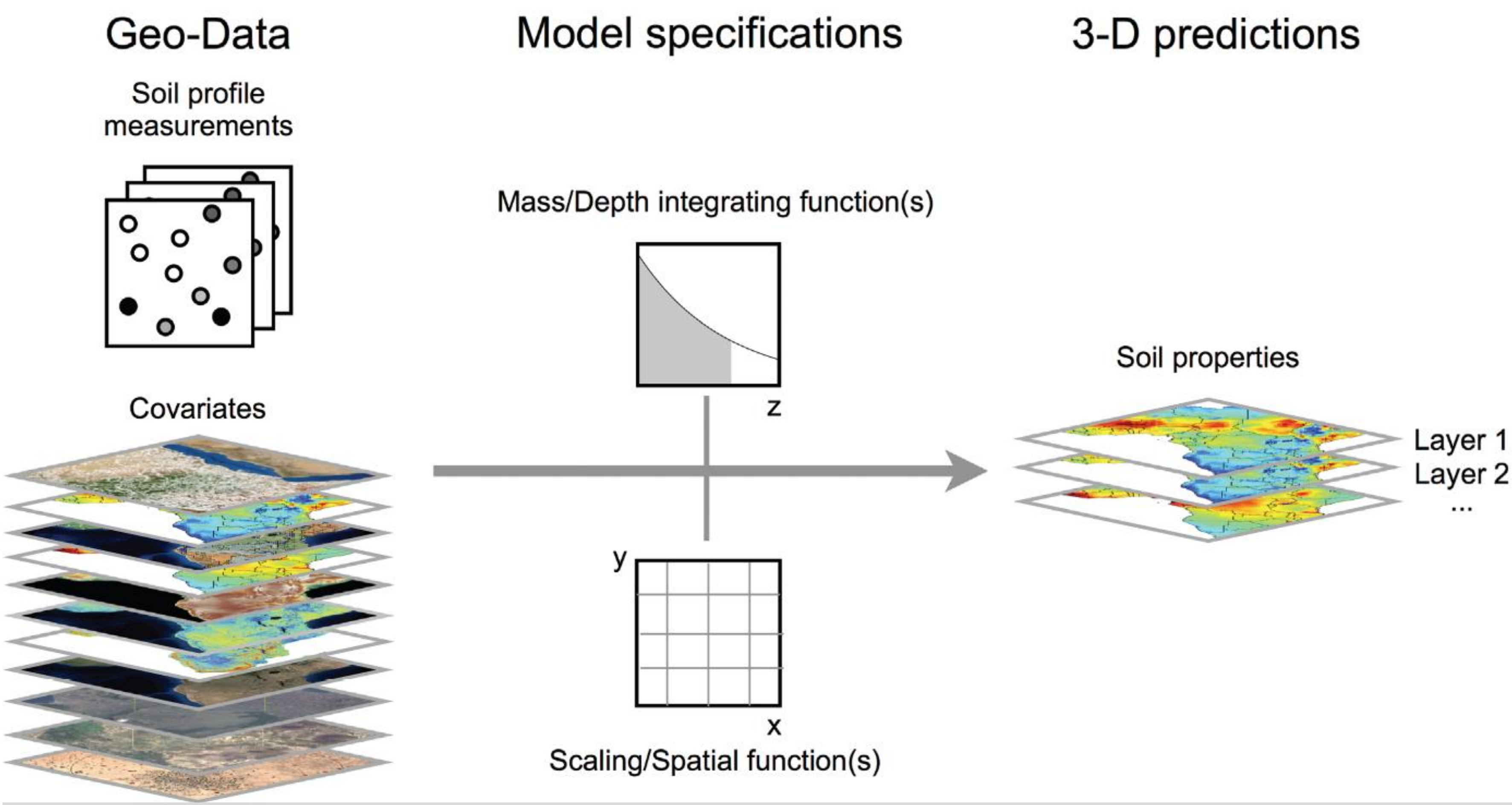
From points to grids: Digital soil mapping



Apply statistical models to predict soil functional properties at unobserved locations in the landscape: $s_i = f(Q)_i + e_i$

Fit model(s)

Soil profile measurements

co-variates

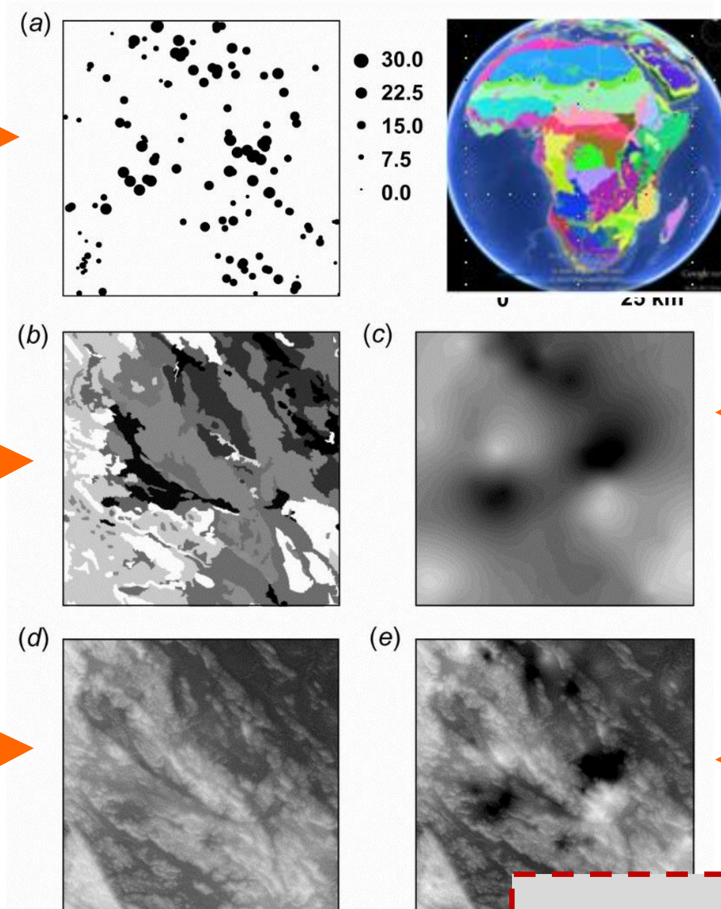
soil map only predictor

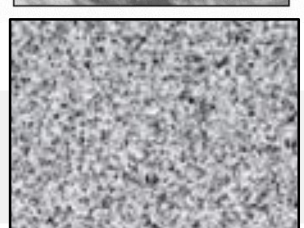
ordinary kriging

regression

regression kriging

machine learning





run model(s) and (cross)validate against independent data sets

SoilGrids

- **Automated** soil information system
- Uses **profile** data and **spatial** information (covariates)
- **Machine learning** algorithms
- Presently: 250 m * 250 m **resolution** (7 depths to 2 m; GSM specs)
- Accessible through **web service** and mobile phone **app**

- Updatable
- Open data
- Moving towards crowd-sourcing

Powered by ISRIC World Soil Information

Hengl et al., 2017 *PLoS ONE* 12, e0169748

SoilGrids clay content at 15 cm (%) depth

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[Hengl et al., 2017 *PLOS ONE* 12, e0169748]

Use of quality-assessed soil information

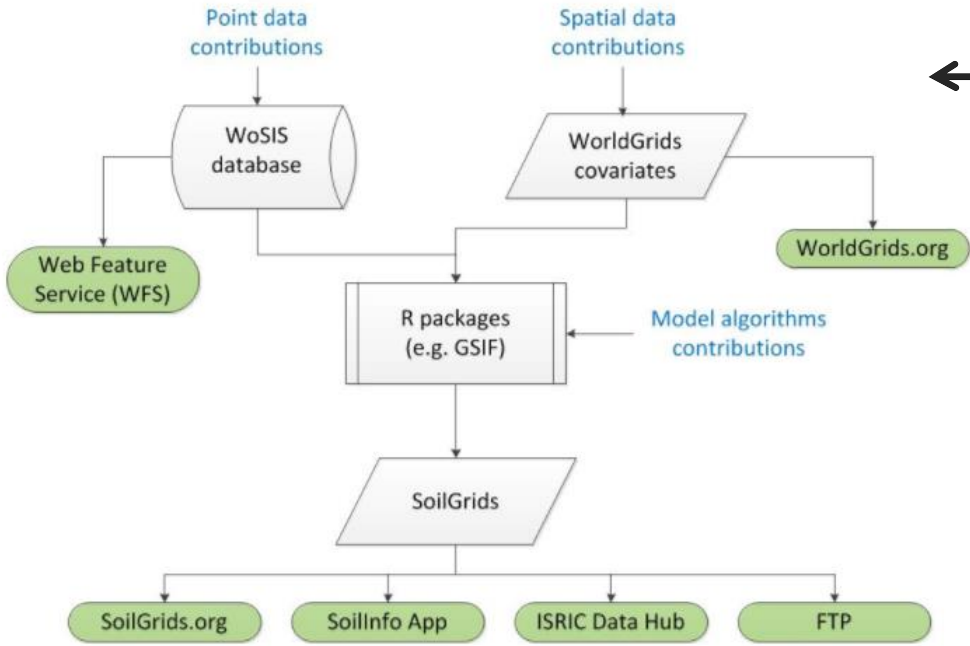
Data sources

Data standard-isation and harmonisation

Data analysis

Soil information (maps)

Use of soil information



Modelling:
Earth system modelling (CIMP), Food security, Carbon sequestration, Land degradation neutrality, etc.

Policy / Decision making

New Data (crowd sourcing; Soilinfo App)

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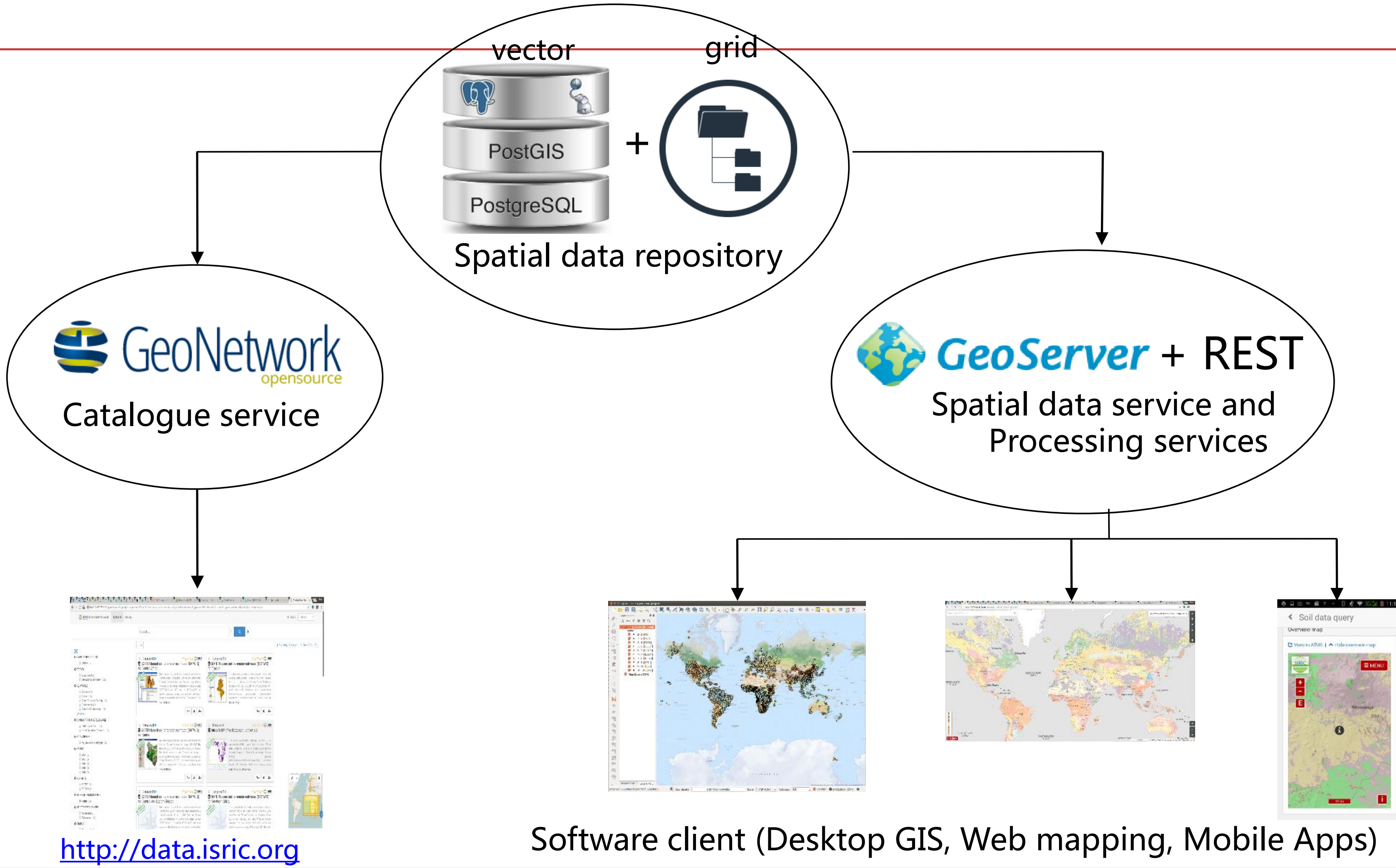
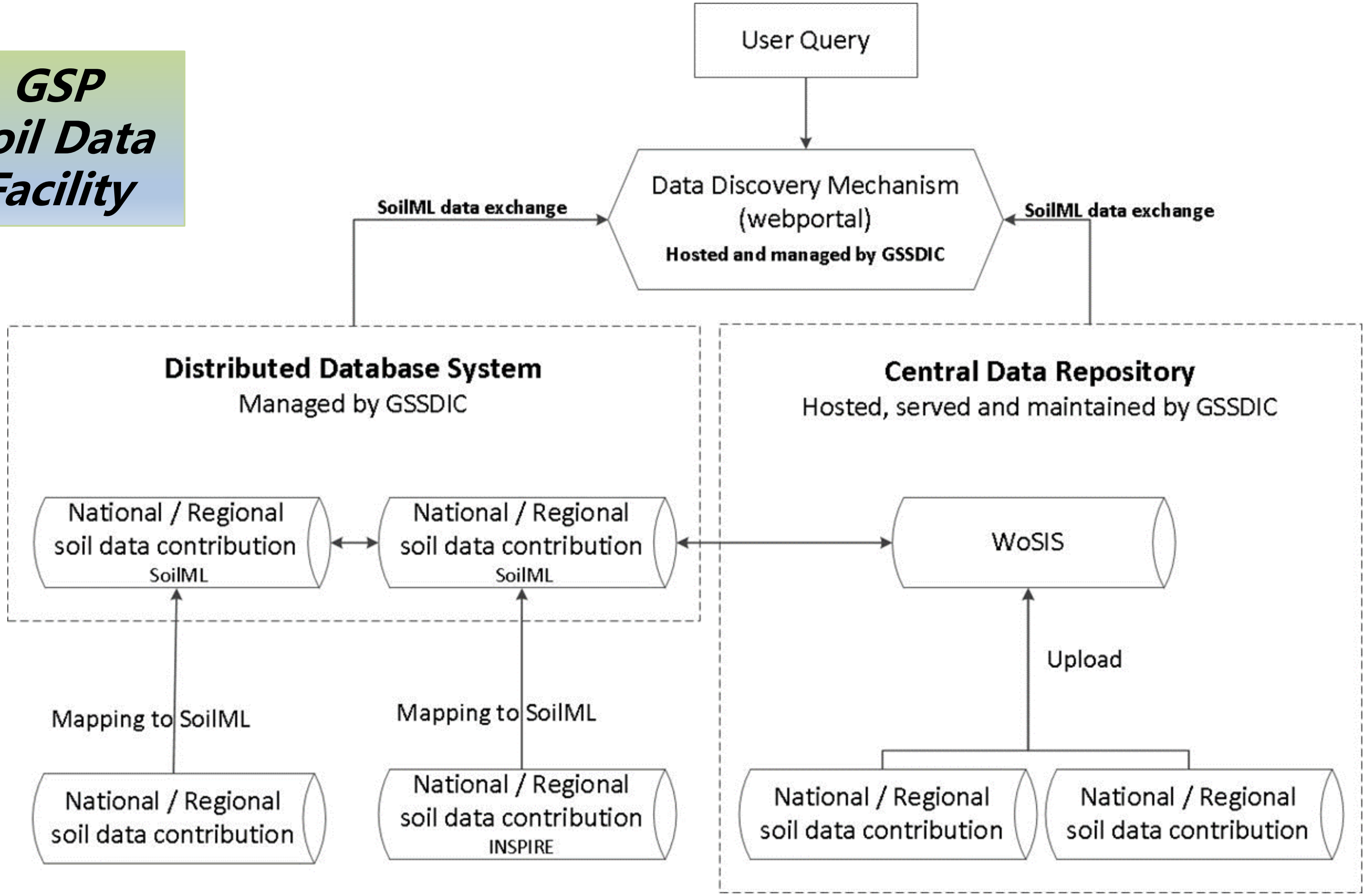
Work in progress ...

Spatial Data Infrastructure



Towards a globally distributed system

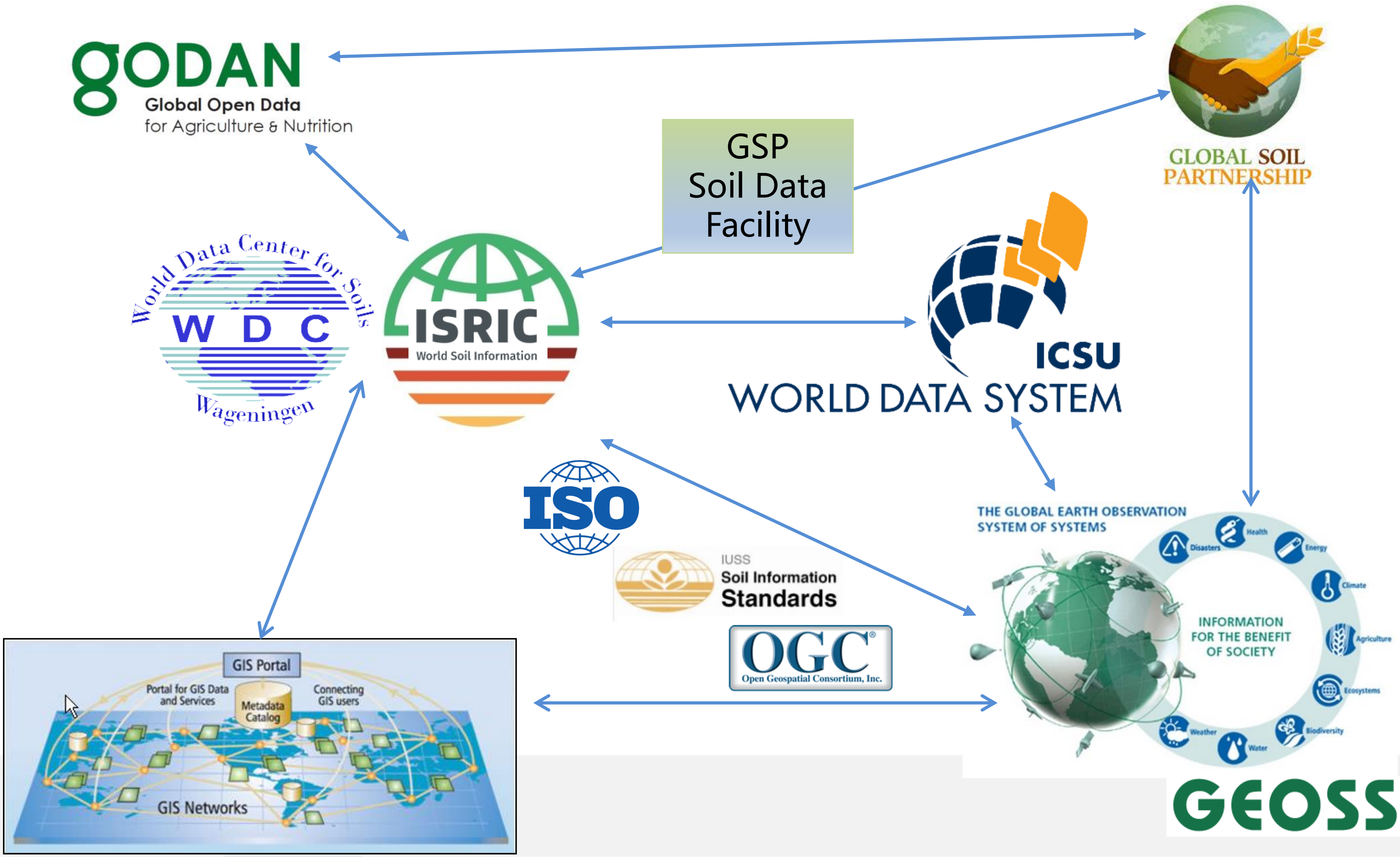
GSP Soil Data Facility



GLOBAL SOIL PARTNERSHIP

Draft - work in progress …

Exchanging 'trustworthy' open soil data, using FAIR principles …



Concluding remarks

- The soil science community should ensure that soil data can be utilised to take effective measures at the desired scales.
- In partnership, we have developed a framework for collating, standardising, mapping, analysing and sharing world soil data.
- The system allows for regular updates of world soil information at user-defined resolutions (250m to 50km).
- We are pro-active in developing soil data inter-operability and exchange formats to underpin the GSP Soil Data Facility.
- There is still much to do; being a small organization ISRIC (WDC-Soils) can only do this in collaboration.

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'ISRIC welcomes cooperation on data sharing and use'

www.isric.org