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An Open Compendium of Soil Datasets

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OpenGeoHub foundation, Wageningen, Netherlands

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Chapter 1

About

1.1 Rationale

This is a public compendium of global, regional, national and sub-national **soil samples** and/or **soil profile** datasets (points with Observations and Measurements of soil properties and characteristics). Datasets listed here, assuming compatible open license, are afterwards imported into the **Global compilation of soil chemical and physical properties and soil classes**¹ and eventually used to create a better open soil information across countries. The specific objectives of this initiative are:

- To enable data digitization, import and binding + harmonization,
- To accelerate research collaboration and networking,
- To enable development of more accurate / more usable global and regional soil property and class maps (typically published via <https://OpenLandMap.org>),

The minimum requirements to submit a dataset for inclusion to the OpenLandMap repository² are:

- License and terms of use clearly specified AND,
- Complete and consistent metadata that can ensure correct standardization and harmonization steps AND,
- At least 50 unique spatial locations AND,
- No broken or invalid URLs,

¹ <https://gitlab.com/openlandmap/>

² <https://gitlab.com/openlandmap/>

Datasets that do NOT satisfy the above listed minimum requirements might be removed. If you discover an issue with license, data description or version number of a dataset, please open a Github issue³.

Recommended settings for all datasets are:

- Peer-reviewed versions of the datasets (i.e. a dataset accompanied with a peer-reviewed publication) should have the priority,
- Register your dataset (use e.g. <https://zenodo.org>) and assign a DOI to each version,
- Provide enough metadata so that it can be imported and bind with other data without errors,
- If your dataset is a compilation of previously published datasets, please indicate in the description,

Information outdated or missing? Please open an issue or best do a correction and then a pull request⁴.

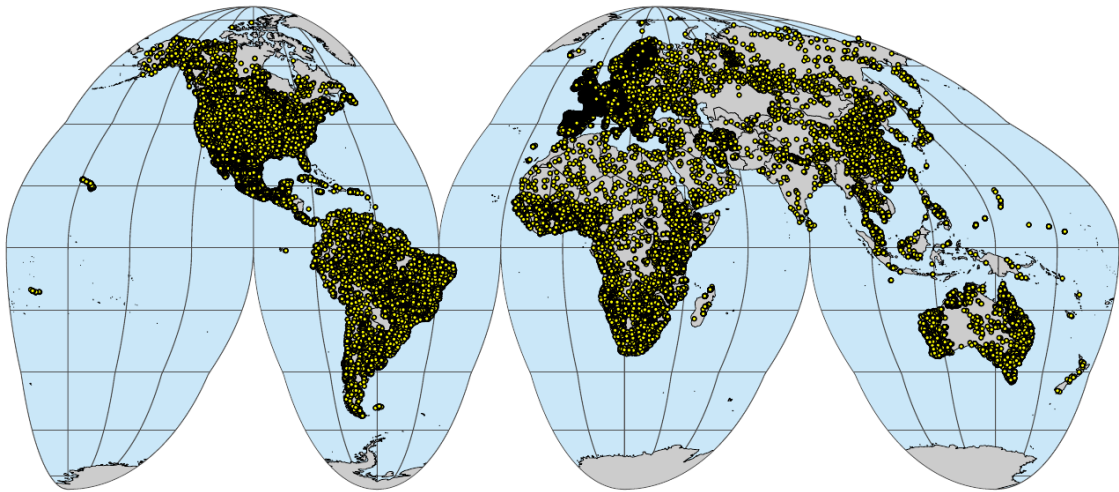


Fig. 1.1 Soil profiles and soil samples with chemical and physical properties global compilation. For more info see: <https://gitlab.com/openlandmap/compiled-ess-point-data-sets>.

³ <https://github.com/OpenGeoHub/SoilSamples/issues>

⁴ <https://docs.github.com/en/github/collaborating-with-issues-and-pull-requests/creating-a-pull-request>

1.2 Existing soil data projects and initiatives

Multiple international organizations from FAO's Global Soil Partnership⁵ to UNCCD's Land Degradation Neutrality⁶, European Commission⁷ and similar, support soil data collation projects and especially curation of the legacy soil data. Some existing soil Observations and Measurements (O&M) soil data initiatives include:

- **Fine Root Ecology Database (FRED)**⁸,
- **FLUXNET global network**⁹,
- **Global database of soil nematodes**¹⁰,
- **Global soil macrofauna database**¹¹,
- **Global soil respiration database (SRDB)**¹²,
- **International Soil Modeling Consortium (ISMC)**¹³,
- **International Soil Moisture Network**¹⁴,
- **International Soil Radiocarbon Database (ISRaD)**¹⁵,
- **International Soil Carbon Network (ISCN)**¹⁶,
- **LandPKS project**¹⁷,
- **Long Term Ecological Research (LTER) Network sites**¹⁸,
- **National Ecological Observatory Network (NEON)**¹⁹,

⁵ <http://www.fao.org/global-soil-partnership/en/>

⁶ <https://www.unccd.int/actions/ldn-target-setting-programme>

⁷ <https://esdac.jrc.ec.europa.eu/>

⁸ <https://roots.ornl.gov/>

⁹ <https://fluxnet.fluxdata.org/>

¹⁰ <https://www.nature.com/articles/s41597-020-0437-3>

¹¹ <http://macrofauna.earthworms.info/>

¹² <https://github.com/bpbond/srdb>

¹³ <https://soil-modeling.org>

¹⁴ <https://ismn.geo.tuwien.ac.at/en/>

¹⁵ <https://soilradiocarbon.org>

¹⁶ <http://iscn.fluxdata.org/>

¹⁷ <http://portal.landpotential.org/#/landpksmmap>

¹⁸ <https://lternet.edu/site/>

¹⁹ <https://www.neonscience.org>

- **Soils Data Harmonization (SoDaH)**²⁰,
- **WoSIS Soil Profile Database**²¹,

A more in-depth inventory of all various national and international soil datasets can be found in:

- Rossiter, D.G.,: **Compendium of Soil Geographical Databases**²²

1.3 Target soil variables

Soil variables of interest include:

1. Chemical soil properties:

- Soil organic carbon, total carbon, total nitrogen,
- Soil pH, effective Cation Exchange Capacity (eCEC),
- Soil sodicity (presence of a high proportion of sodium ions relative to other cations),
- Macro-nutrients: extractable — potassium (K), calcium (Ca), sodium (Na), magnesium (Mg) and similar,
- Micro-nutrients: phosphorus (P), sulfur (S), iron (Fe), zinc (Zn) and similar,
- Soil pollutants, heavy metals and similar,
- Electrical conductivity,

2. Physical soil properties:

- Soil texture and texture fractions: silt, clay and sand, stone content,
- Bulk density, depth to bedrock and similar,
- Hydraulic conductivity, water content — Field Capacity (FC; the amount of water held in the soil after it has been fully wetted and free drainage has stopped), Permanent Wilting Point (PWP; the soil moisture condition at which the plant could not obtain water and would wilt and die), Plant Available Water Capacity (PAWC; the amount of water between field capacity and permanent wilting point water holding capacity) and similar,
- Soil temperature,

3. Soil biological / biodiversity variables:

- Soil biomass,
- Soil micro-, meso-, macro- and mega-fauna abundance,
- Soil biodiversity indices,

²⁰ <https://lter.github.io/som-website>

²¹ <https://www.isric.org/explore/wosis>

²² <https://www.isric.org/explore/soil-geographic-databases>

4. Soil classification / taxonomy variables:

- Soil type,
- Soil suitability classes, soil fertility classes,
- Soil texture classes and families,

5. Soil absorbances / soil spectroscopy variables:

- Soil absorbance in VIS-NIR and MIR part of spectra,

This document is based on the <https://www.bigbookofr.com/> repository by Oscar Baruffa.

1.4 Recommended columns

As a general rule of thumb we recommend all contributors to use the following general scheme to organize Soil Observations & Measurements with 3–4 main tables and metadata + legends organized in other tables:

- Soil site information (geographical coordinates, land use / land cover, soil classification etc),
- Soil horizon information (soil observations and measurements specific to soil layers / diagnostic horizons),
- Proximal soil sensing information including soil scans,

For making soil observations and measurements we recommend following the USDA National Cooperative Soil Survey (NCSS) Soil Characterization Database²³ codes and specification as much as possible. These are explained in detail in the **Kellogg Soil Survey Laboratory Methods Manual**²⁴ and **The Field Book for Describing and Sampling Soils**²⁵. Likewise, **FAO Guidelines for soil description**²⁶, and the FAO's GSOC measurement, monitoring, reporting and verification (MRV) protocol²⁷ also explain in detail how to collect soil samples and setup a system for monitoring soil organic carbon.

It is recommended that one should, as much as possible, use the international standards and references. Some highly recommended protocols and standards include:

- UUID generator tool²⁸ to generate unique ID's for unique soil sites, horizons, samples etc,
- Open Location Codes²⁹ to generate geographic location codes,

²³ <https://ncsslabdatamart.sc.egov.usda.gov/>

²⁴ https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1253872.pdf

²⁵ <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/research/guide/>

²⁶ <http://www.fao.org/3/a0541e/a0541e.pdf>

²⁷ <http://www.fao.org/documents/card/en/c/cb0509en/>

²⁸ <https://cran.r-project.org/package=uuid>

²⁹ <https://opensource.google/projects/open-location-code>

- OGC standards³⁰ to prepare metadata and exchange data across field / computer systems;
- ISO8601³¹ to save time and date information,
- ISO3166³² for country / administrative codes,
- GPS³³ and WGS84 longitude and latitude in decimal degrees to save the location information,
- International DOI foundation³⁴ to refer to specific dataset and/or publication,
- USDA soil classification system³⁵ and World Reference Base³⁶ to classify soils,
- USDA soil texture calculator³⁷ to determine and share soil texture classes including texture-by-hand,
- Kellogg Soil Survey Laboratory Methods Manual³⁸ for reference physical and chemical soil property determination in laboratory,
- Soils Laboratory Manual, K-State Edition³⁹,

1.5 Contributing

Please feel free to contribute entries. See GitHub repository⁴⁰ for more detailed instructions.

1.6 Contributors

If you've contribute, add also your name and Twitter, ORCID or blog link below:

Tomislav Hengl⁴¹, Jonathan Sanderman⁴², Mario Antonio Guevara Santamaria⁴³,

³⁰ <https://www.ogc.org/standards/om>

³¹ https://en.wikipedia.org/wiki/ISO_8601

³² https://en.wikipedia.org/wiki/ISO_3166-1

³³ <https://www.gps.gov/>

³⁴ https://en.wikipedia.org/wiki/Digital_object_identifier

³⁵ <https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/class/>

³⁶ <http://www.fao.org/soils-portal/data-hub/soil-classification/world-reference-base/en/>

³⁷ https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054167

³⁸ https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1253872.pdf

³⁹ <https://kstatelibraries.pressbooks.pub/soilslabmanual/>

⁴⁰ <https://github.com/OpenGeoHub/SoilSamples>

⁴¹ https://twitter.com/tom_hengl

⁴² <https://twitter.com/sandersoil>

⁴³ <https://orcid.org/0000-0002-9788-9947>

1.7 Disclaimer

The data is provided “as is”. OpenGeoHub foundation⁴⁴ and its suppliers and licensors hereby disclaim all warranties of any kind, express or implied, including, without limitation, the warranties of merchantability, fitness for a particular purpose and non-infringement. Neither OpenGeoHub foundation nor its suppliers and licensors, makes any warranty that the Website will be error free or that access thereto will be continuous or uninterrupted. You understand that you download from, or otherwise obtain content or services through, the Website at your own discretion and risk.

1.8 Licence

This website/book is free to use, and is licensed under the Creative Commons Attribution 3.0 License⁴⁵.

1.9 Soil Spectroscopy for Global Good

SoilSpec4GG⁴⁶ is a USDA-funded Food and Agriculture Cyberinformatics Tools Coordinated Innovation Network NIFA Award #2020-67021-32467⁴⁷ project. It brings together soil scientists, spectroscopists, informaticians, data scientists and software engineers to overcome some of the current bottlenecks preventing wider and more efficient use of soil spectroscopy. A series of working groups will be formed to address topics including calibration transfer, model choice, outreach & demonstration, and use of spectroscopy to inform global carbon cycle modeling. For more info refer to: <https://soilspectroscopy.org/>

1.10 About OpenGeoHub

OpenGeoHub foundation is a non-for-profit research foundation located in Wageningen, the Netherlands. We specifically promote publishing and sharing of Open Geographical and Geo-scientific Data, using and developing Open Source Software and encouraging and empowering under-represented researchers e.g. those from ODA recipient countries and female researchers. We believe that the key measure of quality of research in all sciences (and especially in geographical

⁴⁴ <https://opengeohub.org/about>

⁴⁵ <https://creativecommons.org/licenses/by/3.0/>

⁴⁶ <https://soilspectroscopy.org/>

⁴⁷ <https://nifa.usda.gov/press-release/nifa-invests-over-7-million-big-data-artificial-intelligence-and-other>

information sciences) is in transparency and reproducibility of the computer code used to generate results (read more in: “Everyone has a right to know what is happening with the planet”⁴⁸).

1.11 Literature

Some other connected publications and initiatives describing collation and import of legacy soil observations and measurements that might interest you:

- Arrouays, D., Leenaars, J. G., Richer-de-Forges, A. C., Adhikari, K., Ballabio, C., Greve, M., ... & Heuvelink, G. (2017). **Soil legacy data rescue via GlobalSoilMap and other international and national initiatives**⁴⁹. *GeoResJ*, 14, 1-19.
- Batjes, N. H., Ribeiro, E., van Oostrum, A., Leenaars, J., Hengl, T., & de Jesus, J. M. (2017). **WoSIS: providing standardised soil profile data for the world**⁵⁰. *Earth System Science Data*, 9(1), 1. <https://doi.org/10.5194/essd-9-1-2017>
- Billings, S. A., Lajtha, K., Malhotra, A., Berhe, A. A., de Graaff, M. A., Earl, S., ... & Wieder, W. (2021). **Soil organic carbon is not just for soil scientists: measurement recommendations for diverse practitioners**⁵¹. *Ecological Applications*, 31(3), e02290. <https://doi.org/10.1002/eap.2290>
- Brown, G., Demeterio, W. and Samuel-Rosa, A. (2021). **Towards a more open Soil Science**⁵². *SciELO in Perspective*, 2021 [viewed 17 June 2021].
- Gupta, S., Hengl, T., Lehmann, P., Bonetti, S., & Or, D. (2021). **SoilKsatDB: global database of soil saturated hydraulic conductivity measurements for geoscience applications**⁵³. *Earth System Science Data*, 13(4), 1593-1612. <https://doi.org/10.5194/essd-13-1593-2021>
- Hengl, T., MacMillan, R.A., (2019). **Predictive Soil Mapping with R**⁵⁴. OpenGeoHub foundation, Wageningen, the Netherlands, 370 pages, <https://soilmapper.org>, ISBN: 978-0-359-30635-0.
- Moorberg, C. J., & Crouse, D. A. (2017). **An open-source laboratory manual for introductory, undergraduate soil science courses**⁵⁵. *Natural Sciences Education*, 46(1), 1-8.
- Ramcharan, A., Hengl, T., Beaudette, D., & Wills, S. (2017). **A soil bulk density pedo-transfer function based on machine learning: A case study with the NCSS soil**

⁴⁸ <https://opengeohub.medium.com/>

⁴⁹ <https://doi.org/10.1016/j.grj.2017.06.001>

⁵⁰ <http://www.earth-syst-sci-data.net/9/1/2017/>

⁵¹ <https://doi.org/10.1002/eap.2290>

⁵² <https://blog.scielo.org/en/2021/01/08/towards-a-more-open-soil-science/>

⁵³ <https://doi.org/10.5194/essd-13-1593-2021>

⁵⁴ <https://soilmapper.org/>

⁵⁵ <https://doi.org/10.4195/nse2017.06.0013>

characterization database⁵⁶. Soil Science Society of America Journal, 81(6), 1279-1287.
<https://doi.org/10.2136/sssaj2016.12.0421>

- Rossiter, D.G.,: **Compendium of Soil Geographical Databases**⁵⁷.

⁵⁶ <https://doi.org/10.2136/sssaj2016.12.0421>

⁵⁷ <https://www.isric.org/explore/soil-geographic-databases>

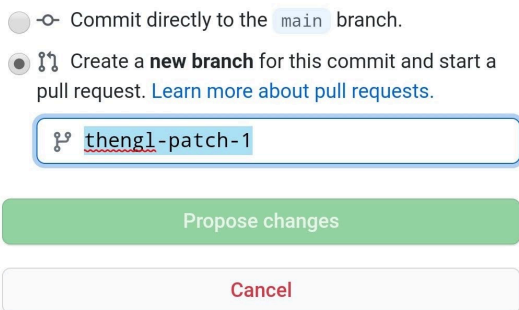
Chapter 2

New to markdown. Start here

2.1 Clone, add reference, submit merge request...

To add a new dataset, please follow these steps:

1. Click on the edit button on the book homepage,
2. Login to Github.com and select “Start a pull-request”,
3. Add new references to 020-dataset_list.Rmd and save,
4. Commit and push and make a pull request¹.
5. Once received we will check it and if you have followed the instructions closely, the reference will appear in the document as soon as the code is merged with the master,



☐ Commit directly to the `main` branch.

☒ Create a **new branch** for this commit and start a pull request. [Learn more about pull requests.](#)

Propose changes

Cancel

Fig. 2.1 Example of a pull request on Github.com.

¹ <https://docs.github.com/en/github/collaborating-with-issues-and-pull-requests/creating-a-pull-request>

If you're new to markdown and want to learn how to use it, please refer to this tutorial².

If you are new to R and/or **pedometrics**³, please consider reading / installing:

- Kabacoff, R.I., (2011) “R in Action: Data Analysis and Graphics with R”⁴. Manning publications, ISBN: 9781935182399, 472 pages.
- California Soil Resource Lab, (2017) “Open Source Software Tools for Soil Scientists”⁵, UC Davis.,
- RStudio⁶,

If you'd like more of a roadmap to guide you through R, have a look at Oscar's blogpost:

- <https://oscarbaruffa.com/a-roadmap-for-getting-started-with-r/>

2.2 Video Course: Getting started with R

If you prefer video instruction with progress tracking:

- <https://rfortherestofus.com/courses/getting-started/>

² <https://guides.github.com/features/mastering-markdown/>

³ <https://pedometrics.org>

⁴ <http://www.manning.com/kabacoff/>

⁵ <https://casoilresource.lawr.ucdavis.edu/software/>

⁶ <http://www.rstudio.com/products/RStudio/>

Chapter 3

Soil data communities and mailing lists

To follow progress of the soil data compilations consider connecting to some of the active communities / registering for the mailing lists and/or discussion groups.

3.1 Pedometrics community

Pedometrics is the commission of the International Union of Soil Sciences. You can read more about pedometrics from <www.pedometrics.org>. There is also Pedometrics mailing list¹ where you can ask more technical questions.

3.2 Digital Soil Mapping community

Digital Soil Mapping community (A Working Group of the International Union of Soil Sciences (IUSS)) can be accessed via the home page <www.digitalsoilmapping.org> and/or via the Facebook group on Digital Soil Mapping².

¹ <https://mailman.sydney.edu.au/mailman/listinfo/pedometrics>

² <https://www.facebook.com/groups/DigitalSoilMapping>

Chapter 4

Datasets

4.1 Global Datasets

4.1.1 Fine Root Ecology Database: FRED (compilation)

Description: Originally a plant root database but also contains some soil laboratory data and soil observations.

- Iversen CM, McCormack ML, Baer JK, Powell AS, Chen W, Collins C, Fan Y, Fanin N, Freschet GT, Guo D, Hogan JA, Kou L, Laughlin DC, Lavelly E, Liese R, Lin D, Meier IC, Montagnoli A, Roumet C, See CR, Soper F, Terzaghi M, Valverde-Barrantes OJ, Wang C, Wright SJ, Wurzbarger N, Zadworny M. (2021). Fine-Root Ecology Database (FRED): A Global Collection of Root Trait Data with Coincident Site, Vegetation, Edaphic, and Climatic Data, Version 3¹. Oak Ridge National Laboratory, TES SFA, U.S. Department of Energy, Oak Ridge, Tennessee, U.S.A.
- Project website: <https://roots.ornl.gov/>
- Data download URL: <https://doi.org/10.25581/ornlsfa.014/1459186>
- Unique locations: 280
- Unique complete rows: 858
- Import steps: chemsprops.FRED²

¹ <https://roots.ornl.gov/>

² <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#fine-root-ecology-database-fred>

4.1.2 *Global Harmonized Dataset of SOC change under perennial crops (compilation)*

Description: Soil Organic Carbon data from various publications. Many missing years for PREVIOUS SOC and SOIL CHARACTERISTICS.

- Ledo, A., Hillier, J., Smith, P. et al. (2019) A global, empirical, harmonised dataset of soil organic carbon changes under perennial crops. Sci Data 6, 57. <https://doi.org/10.1038/s41597-019-0062-1>
- Project website: <https://africap.info/>
- Data download URL: <https://doi.org/10.6084/m9.figshare.7637210.v2>
- Unique locations: 174
- Unique complete rows: 1526
- Import steps: chemsprops.SOCPDB³

4.1.3 *Global Soil Respiration DB (compilation)*

Description: The database encompasses all published studies that report at least one of the following data measured in the field (not laboratory): annual soil respiration, mean seasonal soil respiration, a seasonal or annual partitioning of soil respiration into its source fluxes, soil respiration temperature response (Q10), or soil respiration at 10 degrees C.

- Bond-Lamberty, B. and Thomson, A. (2010). A global database of soil respiration data, Biogeosciences, 7, 1915-1926, <https://doi.org/10.5194/bg-7-1915-2010>
- Project website: <https://github.com/bpbond/srdb/>
- Data download URL: <https://github.com/bpbond/srdb/>
- Unique locations: 826
- Unique complete rows: 1596
- Import steps: chemsprops.SRDB⁴

³ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#global-harmonized-dataset-of-soc-change-under-perennial-crops>

⁴ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#global-soil-respiration-db>

4.1.4 *HYDROS Soil hydraulic functions of international soils (compilation)*

Description: Contains a data base of 173 soil hydrological data (raw data) from 71 sites all over the world (Asia, Africa, Australia America and Europe). The samples were mainly collected and measured as part of research projects. The soils cover a wide range of texture classes and dry bulk densities. The data base consists of water retention and unsaturated hydraulic conductivity data.

- Schindler, Uwe; Müller, Lothar (2015): Soil hydraulic functions of international soils measured with the Extended Evaporation Method (EEM) and the HYPROP device⁵, Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF) e.V.[doi:10.4228/ZALF.2003.273]
- Project website:
- Data download URL: <http://dx.doi.org/10.4228/ZALF.2003.273>
- Unique locations: 71
- Unique complete rows: 173
- Import steps: chemsprops.HYDROS⁶

4.1.5 *ISRIC WISE harmonized soil profile data (compilation)*

Description: ISRIC-WISE database holds selected site and horizon data for 10,250 soil profiles from 149 countries. Profile data were extracted from a wide range of sources and harmonized with respect to the original (1974) and revised (1988) Legend of the FAO-Unesco Soil Map of the World. Profiles have been described, sampled, and analyzed according to methods and standards in use in the originating countries. WISE was specifically developed for land-related applications at continental and global scales.

- Batjes, N.H. (2019). Harmonized soil profile data for applications at global and continental scales: updates to the WISE database⁷. Soil Use and Management 5:124-127. DOI:10.1111/j.1475-2743.2009.00202.x
- Project website: <https://isric.org>
- Data download URL: <https://files.isric.org/public/wise/WD-WISE.zip>

⁵ <http://dx.doi.org/10.4228/ZALF.2003.273>

⁶ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilHydroDB#hydros>

⁷ <http://dx.doi.org/10.1111/j.1475-2743.2009.00202.x>

- Unique locations: 6723
- Unique complete rows: 23278
- Import steps: chemsprops.WISE⁸

4.1.6 *ISRIC World Soil Reference Collection*

Description: World Soil Reference Collection comprises about 800 soil profiles from over 70 countries with detailed soil profile and environmental data.

- Batjes, N. H. (1995). A homogenized soil data file for global environmental research: A subset of FAO, ISRIC and NRCS profiles (Version 1.0) (No. 95/10b)⁹. ISRIC. / Van de Ven, T., & Tempel, P. (1994). ISIS 4.0: ISRIC Soil Information System: User Manual¹⁰. ISRIC.
- Project website: <https://isis.isric.org>
- Data download URL: <https://isis.isric.org>
- Unique locations: 785
- Unique complete rows: 5637
- Import steps: hydrosprops.ISIS¹¹

4.1.7 *Global ICRAF/ISRIC Soil Spectroscopy Library — (ICRAF/ISRIC)*

Description: A Globally Distributed Soil Spectral Library Mid Infrared Diffuse Reflectance Spectra. MIR scans for some 785 profiles from the ISRIC World Soil Reference Collection. The samples are from 58 countries spanning Africa, Asia, Europe, North America, and South America. Data available under the CC-BY 4.0 license.

⁸ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#isric-wise-harmonized-soil-profile-data>

⁹ https://www.isric.org/sites/default/files/isric_report_1995_10b.pdf

¹⁰ https://www.isric.org/sites/default/files/ISRIC_TechPap15b.pdf

¹¹ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilHydroDB#isric-isis>

- World Agroforestry Centre, (2014). The ICRAF/ISRIC spectral library¹², Soil-Plant Spectral Diagnostics laboratory, United Nations Avenue, Nairobi, Kenya.
- Project website: <https://www.worldagroforestry.org/sd/landhealth/soil-plant-spectral-diagnostics-laboratory/soil-spectra-library>
- Data download URL: <https://files.isric.org/public/other/ICRAF-ISRICVNIRSoilDatabase.zip>
- Unique locations: 785
- Unique complete rows:
- Import steps: `sslsprops.ICRAF_ISRIC`¹³

4.1.8 Global database of soil saturated hydraulic conductivity measurements — KSat (compilation)

Description: Contains a total of 13,258 Ksat measurements from 1908 sites were assembled from the published literature.

- Gupta, S., Hengl, T., Lehmann, P., Bonetti, S., and Or, D.: (2021) SoilKsatDB: global database of soil saturated hydraulic conductivity measurements for geoscience applications¹⁴, Earth Syst. Sci. Data, 13, 1593–1612, <https://doi.org/10.5194/essd-13-1593-2021>.
- Project website:
- Data download URL: <https://doi.org/10.5281/zenodo.3752721>
- Unique locations: 1908
- Unique complete rows:
- Import steps: `hydrosprops`¹⁵

¹² https://worldagroforestry.org/sites/default/files/Description_ICRAF-ISRIC%20Soil%20VNIR%20Spectral%20Library.pdf

¹³ <https://gitlab.com/soilspec4gg>

¹⁴ <https://doi.org/10.5194/essd-13-1593-2021>

¹⁵ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilHydroDB>

4.1.9 *LandPKS observations*

Description: Data collected by various people through the LandPKS App for mobile phones (crowdsourced). Data is of limited quality and usually no laboratory data is collected and shared.

- Herrick, J. E., Urama, K. C., Karl, J. W., Boos, J., Johnson, M. V. V., Shepherd, K. D., ... & Kosnik, C. (2013). The Global Land-Potential Knowledge System (LandPKS): Supporting Evidence-based, Site-specific Land Use and Management through Cloud Computing, Mobile Applications, and Crowdsourcing¹⁶. *Journal of Soil and Water Conservation*, 68(1), 5A-12A.
- Project website: <http://portal.landpotential.org>
- Data download URL: <http://portal.landpotential.org/#/landpkmap>
- Unique locations: 15326
- Unique complete rows: 41644
- Import steps: chemsprops.LandPKS¹⁷

4.1.10 *Mangrove forest soil DB (compilation)*

Description: Point data set used to produce a global map of mangrove forest soil carbon at 30 m spatial resolution.

- Sanderman, J., Hengl, T., Fiske, G., Solvik, K., Adame, M. F., Benson, L., ... & Duncan, C. (2018). A global map of mangrove forest soil carbon at 30 m spatial resolution¹⁸. *Environmental Research Letters*, 13(5), 055002.
- Project website: <https://www.woodwellclimate.org/research-area/carbon/>
- Data download URL: <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/OCYUIT>
- Unique locations: 1568
- Unique complete rows: 7718

¹⁶ <https://doi.org/10.2489/jswc.68.1.5A>

¹⁷ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#landpks-observations>

¹⁸ <https://doi.org/10.1088/1748-9326/aabe1c>

- Import steps: chemsprops.Mangroves¹⁹

4.1.11 *Remnant native SOC database (compilation)*

Description: Soil carbon profile data from paired land use comparisons.

- Sanderman, J., Hengl, T., & Fiske, G. J. (2017). Soil carbon debt of 12,000 years of human land use²⁰. *Proceedings of the National Academy of Sciences*, 114(36), 9575-9580.
- Project website: <https://www.woodwellclimate.org/research-area/carbon/>
- Data download URL: <https://doi.org/10.7910/DVN/QQQM8V/8MSBNI>
- Unique locations: 1604
- Unique complete rows: 224
- Import steps: chemsprops.RemnantSOC²¹

4.1.12 *SOils DATA Harmonization database: SoDaH (compilation)*

Description: SoDaH is built on several network science efforts in the United States. It's aim is to provide an open-access resource to facilitate and automate further harmonization and synthesis of soil carbon data.

- Wieder, W. R., Pierson, D., Earl, S., Lajtha, K., Baer, S., Ballantyne, F., ... & Weintraub, S. (2020). SoDaH: the SOils DATA Harmonization database, an open-source synthesis of soil data from research networks, version 1.0²². *Earth System Science Data Discussions*, 1-19. <https://doi.org/10.5194/essd-2020-195>
- Project website: <https://lter.github.io/som-website>
- Data download URL: <https://doi.org/10.6073/pasta/9733f6b6d2ffd12bf126dc36a763e0b4>
- Unique locations: 1052

¹⁹ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#mangrove-forest-soil-db>

²⁰ <https://doi.org/10.1073/pnas.1706103114>

²¹ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#remnant-native-soc-database>

²² <https://doi.org/10.5194/essd-2020-195>

- Unique complete rows: 20383
- Import steps: chemsprops.SoDaH²³

4.1.13 Soil Health DB (compilation)

Description: A database for global soil health assessment. Only limited soil properties available.

- Jian, J., Du, X., & Stewart, R. D. (2020). A database for global soil health assessment. *Scientific Data*, 7(1), 1-8. <https://doi.org/10.1038/s41597-020-0356-3>.
- Project website: <https://github.com/jinshijian/SoilHealthDB>
- Data download URL: <https://github.com/jinshijian/SoilHealthDB>
- Unique locations: 88
- Unique complete rows: 120
- Import steps: chemsprops.SoilHealthDB²⁴

4.1.14 Soil Water Infiltration Global database — SWIG (compilation)

Description: Soil textural information (clay, silt, and sand content) is available for 3842 out of 5023 infiltration measurements.

- Rahmati, M., Weihermüller, L., Vanderborght, J., Pachepsky, Y. A., Mao, L., Sadeghi, S. H., ... & Toth, B. (2018). Development and analysis of the Soil Water Infiltration Global database²⁵. *Earth Syst. Sci. Data*, 10, 1237–1263.
- Project website:
- Data download URL: <https://doi.org/10.1594/PANGAEA.885492>
- Unique locations: 88

²³ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#soils-data-harmonization-database-sodah>

²⁴ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#soil-health-db>

²⁵ <https://doi.org/10.5194/essd-10-1237-2018>

- Unique complete rows: 120
- Import steps: chemsprops.SWIG²⁶

4.1.15 UNSODA Unsaturated Soil Hydraulic Database (compilation)

Description: The dataset contains measured soil water retention, hydraulic conductivity, and water diffusivity data, as well as pedological information of some 790 soil samples from around the world.

- Nemes, Attila; Schaap, Marcel; Leij, Feike J.; Wösten, J. Henk M. (2015). UNSODA 2.0: Unsaturated Soil Hydraulic Database. Database and program for indirect methods of estimating unsaturated hydraulic properties²⁷. US Salinity Laboratory - ARS - USDA. <https://doi.org/10.15482/USDA.ADC/1173246>. / Børgesen, C. D., Jacobsen, O. H., Hansen, S., & Schaap, M. G. (2006). Soil hydraulic properties near saturation, an improved conductivity model. Journal of Hydrology, 324(1-4), 40-50. <https://doi.org/10.1016/j.jhydrol.2005.09.014>
- Project website:
- Data download URL: Zip packages²⁸
- Unique locations: 790
- Unique complete rows:
- Import steps: hydrosprops.UNSODA²⁹

4.1.16 Worldwide organic soil carbon and nitrogen data

Description: A global point data set with organic soil carbon and nitrogen data. Poor spatial location accuracy with error often > 10 km. Bulk density for many points has been estimated not measured. Sampling year has not been but literature indicates: 1965, 1974, 1976, 1978, 1979, 1984. Most of samples come from natural vegetation (undisturbed) areas.

- Zinke, P. J., Millemann, R. E., & Boden, T. A. (1986). Worldwide organic soil carbon and nitrogen data³⁰. Carbon Dioxide Information Center, Environmental Sciences Division, Oak

²⁶ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilHydroDB#swig>

²⁷ <https://data.nal.usda.gov/dataset/unsoda-20-unsaturated-soil-hydraulic-database-database-and-program-indirect-methods-estimating-unsaturated-hydraulic-properties>

²⁸ <https://data.nal.usda.gov/dataset/unsoda-20-unsaturated-soil-hydraulic-database-database-and-program-indirect-methods-estimating-unsaturated-hydraulic-properties>

²⁹ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilHydroDB#unsoda>

³⁰ <https://cdiac.ess-dive.lbl.gov/ftp/ndp018/ndp018.pdf>

Ridge National Laboratory.

- Project website: <https://cdiac.ess-dive.lbl.gov/>
- Data download URL: <https://dx.doi.org/10.3334/CDIAC/lue.ndp018>
- Unique locations: 1712
- Unique complete rows: 3977
- Import steps: chemsprops.ISCND³¹

4.2 Africa

4.2.1 Africa soil profiles database (compilation)

Description: A compilation of legacy soil profiles from hundreds of profiles. Produced for the purpose of the Africa Soil Information Services (AfSIS) project.

- Leenaars, J. G., Van Oostrum, A. J. M., & Ruiperez Gonzalez, M. (2014). Africa soil profiles database version 1.2. A compilation of georeferenced and standardized legacy soil profile data for Sub-Saharan Africa (with dataset)³². Wageningen: ISRIC Report 2014/01; 2014.
- Project website: <https://www.isric.org/projects/africa-soil-profiles-database-afsp>
- Data download URL: <https://data.isric.org/>
- Unique locations: 15630
- Unique complete rows: 60306
- Import steps: chemsprops.AfSPDB³³

³¹ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#worldwide-organic-soil-carbon-and-nitrogen-data>

³² <https://www.isric.org/projects/africa-soil-profiles-database-afsp>

³³ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#africa-soil-profiles-database>

4.2.2 *Africa Soil Information Service (AfSIS1) Soil Chemistry*

Description: Soil spectroscopy-based soil samples datasets. Produced by World Agroforestry Centre (ICRAF), Quantitative Engineering Design (QED), Center for International Earth Science Information Network (CIESIN), The International Center for Tropical Agriculture (CIAT), Crop Nutrition Laboratory Services (CROPNUTS) and Rothamsted Research (RRES) for the purpose of the Africa Soil Information Services (AfSIS) project. Many more samples have been collected in the period 2010–2018.

- Towett, E. K., Shepherd, K. D., Tondoh, J. E., Winowiecki, L. A., Lulseged, T., Nyambura, M., ... & Cadisch, G. (2015). Total elemental composition of soils in Sub-Saharan Africa and relationship with soil forming factors. *Geoderma Regional*, 5, 157-168. <https://doi.org/10.1016/j.geodrs.2015.06.002>
- Project website: <https://github.com/qedsoftware/afsis-soil-chem-tutorial>
- Data download URL: <https://registry.opendata.aws/afsis/>
- Unique locations: 929
- Unique complete rows: 4162
- Import steps: chemsprops.AfSIS1³⁴

4.3 Asia

4.3.1 *Northern circumpolar permafrost soil profiles (compilation)*

Description: Represents parts of Russian Federation and Canada. This data set consists of significantly higher soil organic carbon concentrations.

- Hugelius, G., Bockheim, J. G., Camill, P., Elberling, B., Grosse, G., Harden, J. W., ... & Michaelson, G. (2013). A new data set for estimating organic carbon storage to 3 m depth in soils of the northern circumpolar permafrost region³⁵. *Earth System Science Data (Online)*, 5(2).
- Project website: <https://bolin.su.se/data/ncscd/>
- Data download URL: <http://dx.doi.org/10.5879/ECDS/00000002>

³⁴ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#africa-soil-information-service-afsis-soil-chemistry>

³⁵ <https://doi.org/10.5194/essd-5-393-2013>

- Unique locations: 410
- Unique complete rows: 7104
- Import steps: chemsprops.NCSCD³⁶

4.4 Australia & Oceania

4.5 Europe

4.5.1 Land Use and Coverage Area frame Survey: LUCAS soil

Description: Top-soil samples only (0–20 cm). Currently there are three campaigns with LUCAS soil samples: 2009, 2015 and 2018. This is currently the largest systematic soil sample dataset for EU.

- Orgiazzi, A., Ballabio, C., Panagos, P., Jones, A., & Fernandez-Ugalde, O. (2018). LUCAS Soil, the largest expandable soil dataset for Europe: a review³⁷. *European Journal of Soil Science*, 69(1), 140-153.
- Project website: <https://esdac.jrc.ec.europa.eu/content/lucas-2009-topsoil-data>
- Data download URL: <https://esdac.jrc.ec.europa.eu/content/lucas-2009-topsoil-data>
- Unique locations: 21272
- Unique complete rows: 21272 + 21859
- Import steps: chemsprops.LUCAS³⁸

4.5.2 GEMAS 2009

Description: Geochemical background and threshold for 53 chemical elements in European agricultural soil.

³⁶ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#northern-circumpolar-permafrost-soil-profiles>

³⁷ <https://doi.org/10.1111/ejss.12499>

³⁸ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#lucas-soil>

- Reimann, C., Fabian, K., Birke, M., Filzmoser, P., Demetriades, A., Negrel, P., ... & Anderson, M. (2018). GEMAS: Establishing geochemical background and threshold for 53 chemical elements in European agricultural soil³⁹. *Applied Geochemistry*, 88, 302-318.
- Project website: <http://gemas.geolba.ac.at/>
- Data download URL: <http://gemas.geolba.ac.at/>
- Unique locations: 4026
- Unique complete rows: 4131
- Import steps: chemsprops.GEMAS⁴⁰

4.6 North and Central America

4.7 South America

4.7.1 Sistema de Informacion de Suelos de Latinoamerica: SISLAC (compilation)

Description: A compilation of legacy soil profiles from majority of Latin American countries.

- Alianza Mundial por el Suelo. 2013. Sistema de Informacion de Suelos de Latinoamerica (SISLAC). <https://hdl.handle.net/10568/49611>
- Project website: <http://www.sislac.org/>
- Data download URL: <http://54.229.242.119/sislac/es>
- Unique locations: 14606
- Unique complete rows: 49994
- Import steps: chemsprops.SISLAC⁴¹

³⁹ <https://doi.org/10.1016/j.apgeochem.2017.01.021>

⁴⁰ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#gemas>

⁴¹ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#sislac>

4.7.2 CIFOR peatland points (compilation)

Description: Peatland soil measurements (points) from the literature.

- Murdiyarso, D., Roman-Cuesta, R. M., Verchot, L. V., Herold, M., Gumbrecht, T., Herold, N., & Martius, C. (2017). New map reveals more peat in the tropics (Vol. 189). CIFOR. <https://doi.org/10.17528/cifor/006452>
- Project website: <https://www.cifor.org/>
- Data download URL:
- Unique locations:
- Unique complete rows: 756
- Import steps: chemsprops.Peatlands⁴²

4.8 National Datasets

4.8.1 Australia

4.8.1.1 CSIRO National Soil Site Database (compilation)

Description: National legacy soil profile dataset. Compiled from various projects.

- CSIRO (2020). CSIRO National Soil Site Database. v4. CSIRO. Data Collection. <https://data.csiro.au/collections/collection/CIcsiro:7526v004>.
- Project website: <https://www.csiro.au/en/Do-business/Services/Enviro/Soil-archive>
- Data download URL: <https://doi.org/10.25919/5eeb2a56eac12>
- Unique locations: 13826
- Unique complete rows: 70791
- Import steps: chemsprops.NatSoil⁴³

⁴² <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#cifor-peatland-points>

⁴³ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#csiro-national-soil-site-database>

4.8.2 *Belgium*

4.8.2.1 AARDEWERK-Vlaanderen-2010

Description: Legacy soil profile dataset for Flemish Region.

- Beckers, V., Jacxsens, P., Van De Vreken, Ph., Van Meirvenne, M., Van Orshoven, J. (2011). Gebruik en installatie van de bodemdatabank AARDEWERK-Vlaanderen-2010. Spatial Applications Division Leuven, Belgium. / Ottoy, S., Beckers, V., Jacxsens, P., Hermy, M., & Van Orshoven, J. (2015). Multi-level statistical soil profiles for assessing regional soil organic carbon stocks⁴⁴. *Geoderma*, 253, 12-20. <https://doi.org/10.1016/j.geoderma.2015.04.001>
- Project website: <https://www.dov.vlaanderen.be>
- Data download URL: <https://www.dov.vlaanderen.be>
- Unique locations: 6877
- Unique complete rows: 41310
- Import steps: chemsprops.Vlaanderen2010⁴⁵

4.8.3 *Brazil*

4.8.3.1 A National Soil Profile Database for Brazil (compilation)

Description: National compilation of representative soil profiles. This dataset has been used in FEBR. Data comes primarily from the Radam project (Projeto Radambrasil, 1973–1986).

- Cooper, M., Mendes, L. M. S., Silva, W. L. C., & Sparovek, G. (2005). A national soil profile database for Brazil available to international scientists⁴⁶. *Soil Science Society of America Journal*, 69(3), 649-652. <https://doi.org/10.2136/sssaj2004.0140> / Benedetti, M. M., Curi, N., Sparovek, G., Carvalho Filho, A., & Silva, S. H. G. (2011). Updated Brazilian's georeferenced soil database-an improvement for international scientific information exchanging. *Embrapa*, 1, 309-332.
- Project website:
- Data download URL:

⁴⁴ <https://doi.org/10.1016/j.geoderma.2015.04.001>

⁴⁵ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#aardewerk-vlaanderen-2010>

⁴⁶ <https://doi.org/10.2136/sssaj2004.0140>

- Unique locations: 5086
- Unique complete rows: 10,034
- Import steps:

4.8.3.2 Brazilian Soil Spectral Library — BSSL (compilation)

Description: Compilation of SS data from various projects.

- Demattê, J. A., Dotto, A. C., Paiva, A. F., Sato, M. V., Dalmolin, R. S., Maria do Socorro, B., ... & do Couto, H. T. Z. (2019). The Brazilian Soil Spectral Library (BSSL): A general view, application and challenges⁴⁷. *Geoderma*, 354, 113793. <https://doi.org/10.1016/j.geoderma.2019.05.043>
- Project website: <https://bibliotecaespectral.wixsite.com/english>
- Data download URL:
- Unique locations:
- Unique complete rows: 50,662
- Import steps:

4.8.3.3 Free Brazilian Repository for Open Soil Data — febr (compilation)

Description: Soil legacy data from various projects in Brazil standardized and bind together.

- Samuel-Rosa, A., Dalmolin, R. S. D., Moura-Bueno, J. M., Teixeira, W. G., & Alba, J. M. F. (2020). Open legacy soil survey data in Brazil: geospatial data quality and how to improve it. *Scientia Agricola*, 77(1). <https://doi.org/10.1590/1678-992x-2017-0430>
- Project website: <https://www.pedometria.org/febr/>
- Data download URL: <https://www.pedometria.org/febr/>
- Unique locations: 6098
- Unique complete rows: 7842

⁴⁷ <https://doi.org/10.1016/j.geoderma.2019.05.043>

- Import steps: chemsprops.FEBR⁴⁸

4.8.3.4 Hydrophysical database for Brazilian soils — HYBRAS (compilation)

Description: Contains hydrophysical data for Brazilian soils that seeks to consolidate water retention and saturated hydraulic conductivity data together with basic soil features and the methods of determination of these hydraulic properties.

- Ottoni, M. V., Ottoni Filho, T. B., Schaap, M. G., Lopes-Assad, M. L. R., & Rotunno Filho, O. C. (2018). Hydrophysical database for Brazilian soils (HYBRAS) and pedotransfer functions for water retention⁴⁹. *Vadose Zone Journal*, 17(1).
- Project website: <http://geosgb.cprm.gov.br/geosgb/>
- Data download URL: http://geosgb.cprm.gov.br/geosgb/downloads_en.html
- Unique locations: 445
- Unique complete rows:
- Import steps: hydrosprops.HYBRAS⁵⁰

4.8.4 Canada

4.8.4.1 Agriculture and Agri-Food Canada National Pedon Database

Description: Complete soil profile database. Legacy soil profiles collected in various projects. Over-represents southern parts of Canada / agricultural land.

- Agriculture and Agri-Food Canada National Pedon Database⁵¹.
- Project website: <https://open.canada.ca/data/en/>
- Data download URL: <https://open.canada.ca/data/en/dataset/6457fad6-b6f5-47a3-9bd1-ad14aea4b9e0>
- Unique locations: 3096

⁴⁸ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#febr>

⁴⁹ <http://www.cprm.gov.br/en/Hydrology/Research-and-Innovation/HYBRAS-4208.html>

⁵⁰ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilHydroDB#hybras>

⁵¹ <https://open.canada.ca/data/en/dataset/6457fad6-b6f5-47a3-9bd1-ad14aea4b9e0>

- Unique complete rows: 15946
- Import steps: chemsprops.NPDB⁵²

4.8.4.2 Canadian upland forest soil profile and carbon stocks database

Description: Upper and lower limits for horizons can be negative because convention in Canada is to start counting soil depth from mineral soil (hence O and similar horizons are not counted).

- Shaw, C., Hilger, A., Filiatrault, M., & Kurz, W. (2018). A Canadian upland forest soil profile and carbon stocks database⁵³. *Ecology*, 99(4), 989-989. <https://doi.org/10.1002/ecy.2159>
- Project website:
- Data download URL: Supplement file⁵⁴
- Unique locations: 2347
- Unique complete rows: 15162
- Import steps: chemsprops.CUFS⁵⁵

4.8.5 Chile

4.8.5.1 Chilean Soil Organic Carbon database

Description: Soil carbon samples only.

- Pfeiffer, M., Padarian, J., Osorio, R., Bustamante, N., Olmedo, G. F., Guevara, M., et al. (2020) CHLSOC: the Chilean Soil Organic Carbon database, a multi-institutional collaborative effort⁵⁶. *Earth Syst. Sci. Data*, 12, 457-468, <https://doi.org/10.5194/essd-12-457-2020>.
- Project website:
- Data download URL: <https://doi.org/10.17605/OSF.IO/NMYS3>

⁵² <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#canada-national-pedon-db>

⁵³ <https://doi.org/10.1002/ecy.2159>

⁵⁴ <https://esajournals.onlinelibrary.wiley.com/action/downloadSupplement?doi=10.1002%2Fecy.2159&file=ecy2159-sup-0001-DataS1.zip>

⁵⁵ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#canadian-upland-forest-soil-profile-and-carbon-stocks-database>

⁵⁶ <https://doi.org/10.5194/essd-12-457-2020>

- Unique locations: 12132
- Unique complete rows: 16371
- Import steps: chemsprops.CHLSOC⁵⁷

4.8.6 China (*People's Republic of China*)

4.8.6.1 China data set of soil properties for land surface modeling

Description: National compilation of representative soil profiles. The point data is not available publicly.

- Shangguan, W., Dai, Y., Liu, B., Zhu, A., Duan, Q., Wu, L., ... & Zhang, Y. (2013). A China data set of soil properties for land surface modeling⁵⁸. *Journal of Advances in Modeling Earth Systems*, 5(2), 212-224. <https://doi.org/10.1002/jame.20026>
- Project website: <http://globalchange.bnu.edu.cn/research/data>
- Data download URL:
- Unique locations: 8979
- Unique complete rows:
- Import steps:

4.8.6.2 SOTER soil profiles for China

Description: The Soil and Terrain database for China primary data includes also representative soil profiles.

- Dijkshoorn, K., van Engelen, V., & Huting, J. (2008). Soil and landform properties for LADA partner countries⁵⁹. ISRIC report 2008/06 and GLADA report 2008/03, ISRIC — World Soil Information and FAO, Wageningen.
- Project website: <https://data.isric.org>

⁵⁷ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#chilean-soil-organic-carbon-database>

⁵⁸ <https://doi.org/10.1002/jame.20026>

⁵⁹ https://isric.org/sites/default/files/isric_report_2008_06.pdf

- Data download URL: <https://files.isric.org/public/soter/CN-SOTER.zip>
- Unique locations: 1430
- Unique complete rows: 5105
- Import steps: chemsprops.CNSOTER⁶⁰

4.8.7 Croatia

4.8.7.1 Croatian Soil Pedon data

Description: National legacy soil profile dataset. Somewhat over-represents forest soils.

- Martinovic J., (2000) “Tla u Hrvatskoj”⁶¹, Monografija, Drzavna uprava za zastitu prirode i okolisa, str. 269, Zagreb. ISBN: 9536793059 / Basic F., (2014) “The Soils of Croatia”⁶². World Soils Book Series, Springer Science & Business Media, 179 pp. ISBN: 9400758154
- Project website: <http://www.haop.hr/>
- Data download URL: Complete document⁶³
- Unique locations: 2169
- Unique complete rows: 5746
- Import steps: chemsprops.bpht⁶⁴

4.8.8 Costa Rica

4.8.8.1 Soil Profile DB for Costa Rica

Description: National legacy soil profile database for Costa Rica.

⁶⁰ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#soter-china-soil-profiles>

⁶¹ https://books.google.nl/books?id=k_a2MgAACAAJ

⁶² <https://books.google.nl/books?id=VbJEAAAAQBAJ>

⁶³ https://books.google.nl/books?id=k_a2MgAACAAJ

⁶⁴ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#croatian-soil-pedon-data>

- Mata, R., Vazquez, A., Rosales, A., & Salazar, D. (2012). Mapa digital de suelos de Costa Rica⁶⁵. Asociacion Costarricense de la Ciencia del Suelo, San Jose, CRC. Escala, 1, 200000.
- Project website: <http://www.cia.ucr.ac.cr>
- Data download URL: zip file⁶⁶
- Unique locations: 472
- Unique complete rows: 2042
- Import steps: chemsprops.CostaRica⁶⁷

4.8.9 Germany

4.8.9.1 Stocks of organic carbon in German agricultural soils (BZE_LW)

Description: For protection of data privacy, the coordinate was randomly generated within a radius of 4-km around the planned sampling point.

- Poeplau, C., Jacobs, A., Don, A., Vos, C., Schneider, F., Wittnebel, M., ... & Flessa, H. (2020). Stocks of organic carbon in German agricultural soils—Key results of the first comprehensive inventory⁶⁸. *Journal of Plant Nutrition and Soil Science*, 183(6), 665-681.
- Project website: <https://www.thuenen.de/de/ak/>
- Data download URL: <https://doi.org/10.3220/DATA20200203151139>
- Unique locations: 3104
- Unique complete rows: 17187
- Import steps: chemsprops.BZE_LW⁶⁹

⁶⁵ http://www.cia.ucr.ac.cr/?page_id=139

⁶⁶ <http://www.cia.ucr.ac.cr/wp-content/recursosnaturales/Base%20perfiles%20de%20suelos%20v1.1.rar>

⁶⁷ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#soil-profile-db-for-costa-rica>

⁶⁸ <https://doi.org/10.1002/jpln.202000113>

⁶⁹ https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#stocks-of-organic-carbon-in-german-agricultural-soils-bze_lw

4.8.10 Ghana

4.8.10.1 National soil profile legacy DB

Description: Described in literature but not yet imported to AfSPDB.

- Owusu, S., Yigini, Y., Olmedo, G. F., & Omuto, C. T. (2020). Spatial prediction of soil organic carbon stocks in Ghana using legacy data⁷⁰. *Geoderma*, 360, 114008.
- Project website:
- Data download URL:
- Unique locations:
- Unique complete rows:
- Import steps:

4.8.11 Israel

4.8.11.1 The National Soil Spectral Library of Israel

Description: Compilation of SS data from various projects.

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- Project website: <https://www.modelfarm-aro.org/subject-areas/the-national-soil-spectral-library-of-israel/?lang=en>
- Data download URL:
- Unique locations:
- Unique complete rows: 4000
- Import steps:

4.8.12 Iran (Islamic Republic of Iran)

⁷⁰ <https://doi.org/10.1016/j.geoderma.2019.114008>

4.8.12.1 Iran soil profile DB

Description: National legacy soil profile dataset.

- Mohammad, H. B. (2000). Soil resources and use potentiality map of Iran. Soil and Water Research Institute, Teheran, Iran. / Dewan, M. L., & Famouri, J. (1964). The soils of Iran. Food and Agriculture Organization of the United Nations.
- Project website:
- Data download URL:
- Unique locations: 1373
- Unique complete rows: 4759
- Import steps: chemsprops.IRANSPDB⁷¹

4.8.13 Namibia

4.8.13.1 A SOTER database for Namibia: NAMSOTER

Description: Legacy soil profile dataset.

- Coetzee, M. E. (2001). NAMSOTER, a SOTER database for Namibia⁷². Agroecological Zoning, 458.
- Project website:
- Data download URL:
- Unique locations: 1014
- Unique complete rows: 2953
- Import steps: chemsprops.LandPKS⁷³

⁷¹ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#iran-soil-profile-db>

⁷² <https://edepot.wur.nl/485173>

⁷³ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#landpks-observations>

4.8.14 *Switzerland*

4.8.14.1 Swiss National Soil Spectral Model Library

Description: National SS library.

- Baumann, P., Helfenstein, A., Gubler, A., Keller, A., Meuli, R. G., Wächter, D., ... & Six, J. (2021). Developing the Swiss soil spectral library for local estimation and monitoring⁷⁴. SOIL Discussions, 1-32. <https://doi.org/10.5194/soil-2020-105>
- Project website:
- Data download URL:
- Unique locations:
- Unique complete rows:
- Import steps:

4.8.15 *Russian Federation*

4.8.15.1 The Unified State Register of Soil Resources: EGRPR

Description: All documentation in Russian only.

- Stolbovoy V.S., Molchanov E.N., Sheremet B.V. Morphogenetic basis of the unified state register of soil resources of Russia. Dokuchaev Soil Bulletin. 2016;(86):115-123. <https://doi.org/10.19047/0136-1694-2016-86-115-123>
- Project website:
- Data download URL: <http://egrpr.esoil.ru/content/1DB.html>
- Unique locations: 802
- Unique complete rows: 4137
- Import steps: chemsprops.EGRPR⁷⁵

⁷⁴ <https://doi.org/10.5194/soil-2020-105>

⁷⁵ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#egrpr>

4.8.16 USA

4.8.16.1 National Cooperative Soil Survey Characterization Database

Description: National Cooperative Soil Survey Characterization Database is probably the most comprehensive and most detailed soil profile dataset in the World. It is continuously maintained by the USDA National Cooperative Soil Survey. Data is available under the CC-0 license⁷⁶.

- O’Geen, A., Walkinshaw, M., & Beaudette, D. (2017). SoilWeb: A multifaceted interface to soil survey information. *Soil Science Society of America Journal*, 81(4), 853-862. <https://doi.org/10.2136/sssaj2016.11.0386n>
- Project website: <http://ncsslalabdatamart.sc.egov.usda.gov/>
- Data download URL: <http://ncsslalabdatamart.sc.egov.usda.gov/>
- Unique locations: 19861
- Unique complete rows: 136011
- Import steps: chemsprops.NCSS⁷⁷

4.8.16.2 USDA National Soil Survey Center’s Kellogg Soil Survey Laboratory — (NSSC KSSL)

Description: MIR spectral library and associated soil characterization database, which now includes >50,000 MIR spectra collected on soils primarily from the United States. Currently not available publicly for use.

- Seybold, C. A., Ferguson, R., Wysocki, D., Bailey, S., Anderson, J., Nester, B., ... & Thomas, P. (2019). Application of Mid-Infrared Spectroscopy in Soil Survey⁷⁸. *Soil Science Society of America Journal*, 83(6), 1746-1759. <https://doi.org/10.2136/sssaj2019.06.0205> / Sanderman, J., Savage, K., & Dangal, S. R. (2020). Mid-infrared spectroscopy for prediction of soil health indicators in the United States. *Soil Science Society of America Journal*, 84(1), 251-261. <https://doi.org/10.1002/saj2.20009>
- Project website: <https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/research/>
- Data download URL:

⁷⁶ <https://creativecommons.org/share-your-work/public-domain/cc0/>

⁷⁷ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#national-cooperative-soil-survey-characterization-database>

⁷⁸ <https://doi.org/10.2136/sssaj2019.06.0205>

- Unique locations: 61103
- Unique complete rows:
- Import steps: `sslsprops.KSSL`⁷⁹

4.8.16.3 Rapid Carbon Assessment: RaCA

Description: Locations of each site have been degraded due to confidentiality and only reflect the general position of each site.

- Wills, S. et al. (2013) “Rapid carbon assessment (RaCA) methodology: Sampling and Initial Summary. United States Department of Agriculture.”⁸⁰ Natural Resources Conservation Service, National Soil Survey Center.
- Project website: <https://www.nrcs.usda.gov/survey/raca/>
- Data download URL: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/research/?cid=nrcs142p2_054164
- Unique locations: 6332
- Unique complete rows: 143006
- Import steps: `chemsprops.RaCa`⁸¹

4.9 Other datasets

⁷⁹ <https://gitlab.com/soilspec4gg>

⁸⁰ https://www.nrcs.usda.gov/wps/PA_NRCSCconsumption/download?cid=nrcs142p2_052841&ext=pdf

⁸¹ <https://gitlab.com/openlandmap/compiled-ess-point-data-sets/-/tree/master/themes/sol/SoilChemDB#rapid-carbon-assessment-raca>