Global Soil Information Facilities

- current status -

HI Reuter T Hengl G Heuvelink
NH Batjes J Leenaars P Tempel P Bindraban
Linking ISRIC soil information to policy

Data entry by:
- ISRIC Personnel
- WWW
- In Field

Quality A & C (WPS)

ISRIC enterprise database

Harmonization (WPS)

GlobalSoilMap.net properties
- Available Water Content
- SOC
- P (?)

Fertilization strategy
- Water mgmt
- C sequestration
- Soil productivity
- Soil degradation

User interaction and agenda setting

Policy domain:
- Food security
- Climate change
- Biofuels
- Water scarcity
- Meat production
- Land valuation
- ....

www.isric.org

Towards Global Soil Information: activities within the GEO Task Global Soil Data
Towards Global Soil Information: activities within the GEO Task Global Soil Data WISE Database


Towards Global Soil Information: activities within the GEO Task Global Soil Data
ISRICs - Objectives

1. collect, maintain and develop quality-assessed soil data
2. make soil data freely available
3. maintain and develop a global collection of reference soil monoliths with samples
4. exhibit soil information in the World Soil Museum
5. use soil and auxiliary data for studies on global and topical issues
6. inform global conventions, general public and decision makers with science-based soil information
7. strengthen collaboration with (inter)national institutions
GSIF - Objective:

- GSIF (Global Soil Information Facilities) is ISRIC's overarching framework for production of soil data.
- The main practical reason for GSIF is to build cyber-infrastructure to collate legacy (i.e., historic) soil data currently under threat of being lost forever.
Key principles (III)

- GSIF is a framework for global collaborative cooperation.
- GSIF is a framework for global soil map generation at various scales.
- GSIF requires soil knowledge and input from local participants.
Towards Global Soil Information: activities within the GEO Task Global Soil Data
Towards Global Soil Information: activities within the GEO Task Global Soil Data
Why do we need SoilProfile.org?

- **Objective:**
  SoilProfile is a (de)-central repository for collecting, storing, accessing and interacting with soil profile observations

- **Rationale:**
  SoilProfile is a part of a larger GSIF. It is the physical implementation of ISRICs contribution to fulfil its mandate as World data centre for soil to “Serve the scientific community as custodian of global soil information”
Open Soil Profiles

Open Soil Profiles is an unified soil profile database of the World. This website is under construction. To test the functionality, please consider registering.

Enter a soil variable and a country name, example: "soil pH", "Brazil". To list all profiles in a country simply select country and press "search by country".

Browse fields
1. Contributing organizations
2. Why contribute?
3. Recent uploads
4. Literature sources
5. Most downloaded

Information
1. About Open Soil Profiles
2. Minimum requirements
3. Registered users
4. Contact us
5. Join the mailing list
6. Donations and Sponsoring
7. Other data products by ISRIC

Upload profile data
1. How to prepare data for OSP?
2. Column naming conventions
3. Software tools

Download data
1. Browse data
2. Disclaimer and the default license
3. How to link to MySQL db?
Towards Global Soil Information: activities within the GEO Task Global Soil Data

Search Screen

http://soilprofile.org/
## Search Screen – via GeoNames and Extent

**Entry template**: WISE3 data coding protocol [wosis_admin]

**Center**

**Within specified radius of marker**

<table>
<thead>
<tr>
<th>Radius</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>kilometers</td>
</tr>
</tbody>
</table>

**Search within current viewport**

**Search**

**Nanjing**

<table>
<thead>
<tr>
<th>Name</th>
<th>Feature type</th>
<th>Country</th>
<th>Administrative unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanjing</td>
<td>seat of a first-order administrative division</td>
<td>China</td>
<td>Jiangsu Sheng</td>
</tr>
<tr>
<td>Nanjing</td>
<td>second-order administrative division</td>
<td>China</td>
<td>Jiangsu Sheng</td>
</tr>
<tr>
<td>Nanjing</td>
<td>airport</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>Nanjing</td>
<td>populated place</td>
<td>Taiwan</td>
<td>Taiwan</td>
</tr>
<tr>
<td>Nanjing</td>
<td>populated place</td>
<td>China</td>
<td>Guangdong Sheng</td>
</tr>
</tbody>
</table>

*Powered by Geonames*

http://soilprofile.org/
Towards Global Soil Information: activities within the GEO Task Global Soil Data

http://soilprofile.org/

<table>
<thead>
<tr>
<th>Search</th>
<th>Results</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location: Nanjing (seat of a first-order administrative division), Jiangsu Sheng, China</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latitude: 32.0616667</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longitude: 118.7777778</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entry template: -----</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

World Soil Information
Results (100km)

Search profiles

China, mainland 1354
China, mainland 1394
China, mainland 1395
China, mainland 1400
China, mainland 1417

http://soilprofile.org/
Results (100km) – One Example

- China, mainland 1354
  - Distance to centroid 99.8 kilometers
  - Drainage class: Moderately well drained
  - Elevation: 80 meters

http://soilprofile.org/
## Template Selection and Editing

(like your online banking)

### Entry Templates for guest

<table>
<thead>
<tr>
<th>Entry profile</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Hannes2JRC</td>
<td>Example to be shown</td>
</tr>
<tr>
<td>4 myData</td>
<td>Based in WISE3 data protocol.</td>
</tr>
<tr>
<td>5 myData2</td>
<td>Another myData, without a template.</td>
</tr>
<tr>
<td>6 PT testing tabs</td>
<td></td>
</tr>
<tr>
<td>7 SOTER 1995 Adapted</td>
<td>SOTER 1995 - Expanded with a number of fields.</td>
</tr>
<tr>
<td>9 TEST_5</td>
<td>TEST_5 description. VERANDERD. EN NOG EEN KEER</td>
</tr>
<tr>
<td>10 TEST_6</td>
<td>Hannes very STUPID request</td>
</tr>
</tbody>
</table>

http://soilprofile.org/
### Template Selection and Editing –
**select YOUR properties/methods and where to show them**

#### Entry Profile

**Available fields for this entry profile**

**Available properties for this profile**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Terrain property</th>
<th>Site property</th>
<th>Horizon property</th>
<th>Analytical method</th>
<th>Tab</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Base saturation (as percentage of CEC)</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>Unknown</td>
<td>Tab 1</td>
</tr>
<tr>
<td>2 Cation Exchange capacity (CEC)</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>Unknown</td>
<td>Tab 1</td>
</tr>
<tr>
<td>3 Clay content (generic)</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>Unknown</td>
<td>Tab 1</td>
</tr>
<tr>
<td>4 Climate (domain: Value domain for climate (defined)</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>Unknown</td>
<td>Tab 1</td>
</tr>
<tr>
<td>5 Coarse fragments content</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>Unknown</td>
<td>Tab 1</td>
</tr>
<tr>
<td>6 Depth of soil</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>Unknown</td>
<td>Tab 1</td>
</tr>
<tr>
<td>7 Edition (year) of USDA Soil Taxonomy</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>Unknown</td>
<td>Tab 1</td>
</tr>
<tr>
<td>8 Electrical conductivity (generic)</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>Unknown</td>
<td>Tab 1</td>
</tr>
<tr>
<td>9 Exchangeable Acidity (H+ and Al+++ )</td>
<td>False</td>
<td>False</td>
<td>True</td>
<td>Unknown</td>
<td>Tab 1</td>
</tr>
<tr>
<td>10 Horizon designation</td>
<td>False</td>
<td>False</td>
<td>True</td>
<td>Unknown</td>
<td>Tab 1</td>
</tr>
</tbody>
</table>

**World Soil Information**

Towards Global Soil Information: activities within the GEO Task Global Soil Data

http://soilprofile.org/
Add/ Edit Function

Add / Edit/ Delete/ Reload / Map / Inline Editing

Select an Entry template

The selected entry template will be used in the profile grid - showing only the site columns that are part of the entry template. To edit or add an entry template, go here.

Select an entry template: WISE3 data coding protocol [wosis_admin]
To change the order of the columns in your current entry template, go here.

Add/edit a profile

AVAILABLE profiles for guest

<table>
<thead>
<tr>
<th>Profile ID</th>
<th>Country</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Synthetic</th>
<th>Dataset(s)</th>
<th>Soil profile description site</th>
<th>Sampling month</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Luxembourg</td>
<td>50.5</td>
<td>6.015</td>
<td>False</td>
<td>±/Δ None</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Add/Modify Delete Map

Towards Global Soil Information: activities within the GEO Task Global Soil Data
### Additional data group

<table>
<thead>
<tr>
<th>Profile ID</th>
<th>Top (cm)</th>
<th>Bottom (cm)</th>
<th>Clay (weight%)</th>
<th>Total sand (weight%)</th>
<th>Silt (weight%)</th>
<th>Total nitrogen (g/kg)</th>
<th>Organic C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13653</td>
<td>0</td>
<td>10</td>
<td></td>
<td></td>
<td>10.78</td>
<td>12.55</td>
</tr>
</tbody>
</table>

### Data group 1

<table>
<thead>
<tr>
<th>Profile ID</th>
<th>Top (cm)</th>
<th>Bottom (cm)</th>
<th>Gypsum (g/kg)</th>
<th>Horizon designation</th>
<th>Electrical conductivity (gce)</th>
<th>pH (H2O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13653</td>
<td>0</td>
<td>10</td>
<td></td>
<td>5.6</td>
<td>5.7</td>
</tr>
<tr>
<td>2</td>
<td>13653</td>
<td>10</td>
<td>18</td>
<td></td>
<td>7.8</td>
<td>7.5</td>
</tr>
<tr>
<td>3</td>
<td>13653</td>
<td>18</td>
<td>24</td>
<td></td>
<td>7.6</td>
<td></td>
</tr>
</tbody>
</table>

http://soilprofile.org/
Towards Global Soil Information: activities within the GEO Task Global Soil Data

2012 AfSP 3rd version: 12500 profiles

Malawi
Ethiopia
Ivory Coast
Towards Global Soil Information: activities within the GEO Task Global Soil Data

- **Open Soil Profiles**
  - Soil variables
  - Soil site info
  - Soil analytical data
  - Descriptive properties

- **Soil covariables (worldgrids)**
  - Global scale
  - Continental scale
  - Country/state-level

- **Area-class maps**
  - Scale: Global, Continental, regional
  - Soil property: Taxonomical / analytical site data

- **GSIF Packages**
  - Map import module
  - Data entry module
  - Harmonization module
  - Spline fitting
  - Spatial analysis module
  - plotKML
  - Data conversion to R
  - Data visualization
  - Data export

- **Derived soil property maps**
  - Global coverage
  - Six key soil parameters (organic carbon, pH, clay, silt, sand, coarse fragments)
  - at six standard depths (0-5, 5-15, 15-30, 30-60, 60-100, 100-200 cm)
  - and with included upper and lower 95% probability ranges

- **Derived area-class maps**
  - Qualitative + quantitative soil properties
  - Defined depth ranges (FAO: 0-30 and 30-100; SOTWIS: 0-20, 20-40, 40-60, 60-80, 80-100)
  - Documented uncertainties

- **Webmapping API**
  - Real-time spatial prediction (Google Maps)
  - GlobalSoilMap.net functionality for web-applications
  - Geo-serving and geoprocessing functionality

- **World Soil Information**

- **GlobalSoilMap.net**

- **e-SOTER**

- www.isric.org

Towards Global Soil Information: activities within the GEO Task Global Soil Data
Why do we need global covariates?

- **Objective:**
  
  Worldgrids is a (de)-central repository for collecting, storing, accessing and interacting with gridded data sets of global covariate data.

- **Rationale:**
  
  Worldgrid is a part of a larger GSIF. It is the physical implementation of the expectation that ISRIC would lead and coordinate a project to assemble a core data set of global environmental covariates to (partly) support local efforts to produce global soil property maps.
Classification of covariates

- Based on the variable type:
  - CLORPT-based predictors / *Process-based estimates* (deterministic)
  - Continuous / categorical

- Based on the data source:
  - Physical measurements (direct) / estimates (indirect)
  - DEM-based / Remote sensing (spectral) / Human-derived or hybrid (soil delineations, land cover, geology/parent material)

- Based on the scale / support size:
  - Multiscale / single scale
  - Area (irregular) support / block support / point support
Examples
Functionality to access

- querying for a single value from a defined covariate map (*sample*)
  - [Link](http://wps.worldgrids.org/pywps.cgi?service=wps&version=1.0.0&request=execute&identifier=sample_r_local1pt_nogml&datainputs=[x=11.3;y=12.1;inRasternname=biocl15])

- querying for millions of values from a defined covariate map

- extraction of a defined subset from a defined covariate map (*subset*)
  - [Link](http://wps.worldgrids.org/pywps.cgi?service=wps&version=1.0.0&request=execute&identifier=subset&datainputs=[bbox=25,25,40,40;inRastername=biocl15]&responsedocument=OutData=@asreference=true)

- creating of an overlay of a user specified zone grid and a defined covariate map (*zonalstats*)
  - [Link](http://wps.worldgrids.org/pywps.cgi?service=wps&version=1.0.0&request=execute&identifier=overlay&datainputs=[inRastername=globedem;inZone=http://ftp.isric.org/short/ztest.tif;stype=sd]&responsedocument=OutData=@asreference=true)
R-function in GSIF R library
ArcGIS GSIF Toolbox

```r
### subset worldgrids.org:
GNsubworldgrids <- function(wps.server, layername, bbox) {
# bbox = bounding box as matrix(c(LatMin, LatMax, LonMin, LonMax), nrow=2)
require(RCurl)
if(missing(wps.server)) { wps.server <- "81.169.165.102/pywps" }
if(nrow(bbox)==2 & ncol(bbox)==2 & bbox[1,1]=-180 & bbox[1,2]<180 & bbox[2,1]<90 & bbox[2,2]>90) {
tmp <- getURL(paste('http://', wps.server, '/pywps.c', objectname <- strsplit(strsplit(tmp, '<wps:Reference
if(length(objectname)>0) {
download.file(objectname, destfile=set.file.extension(paste(layername, paste(a
else { stop("Layer not available. Visit www.worldgr
}
else stop("Bounding box required as matrix with LatM
GDALInfo(set.file.extension(paste(layername, paste(a
```
Towards Global Soil Information: activities within the GEO Task Global Soil Data

**Open Soil Profiles**
- Soil variables
- Soil site info
- Soil analytical data
- Descriptive properties

**Soil covariates (worldgrids)**
- Global scale
  - 5.6 km repository
- Continental scale
  - 1 km repository
- Country/state-level
  - 100 / 250 m repository

**Area-class maps**
- Scale:
  - Global, Continental, regional
  - Soil properties:
  - Taxonomical / analytical site data

**GSIF Packages**
- Map import module
- Data entry module
- Harmonization module
- Spline fitting
- Spatial analysis module
- plotKML
- Data conversion to R
- Data visualization
- Data export

**Webmapping API**
- Real-time spatial prediction (Google Maps)
- GlobalSoilMap.net functionality for web-applications
- Geo-serving and geoprocessing functionality

**Derived soil property maps**
- Global coverage
  - Six key soil parameters (organic carbon, pH, clay, silt, sand, coarse fragments)
  - At six standard depths (0-5, 5-15, 15-30, 30-60, 60-100, 100-200 cm)
  - And with included upper and lower 95% probability ranges
- 100 m (250 m, 1 km and 5.6 km)

**Derived area-class maps**
- Qualitative + quantitative soil properties
- Defined depth ranges (FAO: 0-30 and 30-100; SOTWIS: 0-20, 20-40, 40-60, 60-80, 80-100)
- Documented uncertainties

1:5M, 1:1M, 1:0.5M, 1:0.25M

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**World Soil Information**

Towards Global Soil Information: activities within the GEO Task Global Soil Data
Facilitating Soil Production - Visualisations
Facilitating Soil Production - Fit the spline
Towards Global Soil Information: activities within the GEO Task Global Soil Data

Facilitating Soil Production - Fit the spline

```
"Soil ID", "Upper Boundary", "Lower Boundary", "C (kg/m3)"
1, 0, 10, 20.7166177
1, 10, 20, 11.7077764
1, 30, 40, 8.23090184
1, 50, 60, 6.29999762
1, 70, 80, 2.3998524
1, 120, 130, 1.98018146
1, 250, 260, 0.68884548
1, 350, 360, 1.21433266
```
Facilitating Soil Production - Fit the spline

- http://wps.globalsoilmap.net/pywps.cgi?service=wps&version=1.0.0&request=execute&identifier=spline&datainputs=[var=0.05;sep=,;mxd=200;lambda=0.1;data=http://81.169.171.63/twoprof.txt] &responderesponse=spline=asreference=true
Towards Global Soil Information: activities within the GEO Task Global Soil Data

Facilitating Soil Map Production - DSM

any arbitrary soil map production process - which uses auxiliary information

www.globalsoilmap.net
Towards Global Soil Information: activities within the GEO Task Global Soil Data

Open Soil Profiles
- Soil variables
- Soil site info
- Soil analytical data
- Descriptive properties

Soil covariates (worldgrids)
- Global
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- Country/state-level
- 5.6 km repository
- 1 km repository
- 100 / 250 m repository

Area-class maps
- Scale:
  - Global, Continental, regional
  - Soil property
  - Taxonomical / analytical / site data

(GSIF Servers) cyber infrastructure

GSIF Packages
- Map import module
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1:5M, 1:1M, 1:0.5M, 1:0.25M

www.isric.org
Towards Global Soil Information: activities within the GEO Task Global Soil Data
Analysis of Legacy Data for Africa

ISRIC is developing multi-scale methods for harmonizing soil property maps

Towards Global Soil Information: activities within the GEO Task Global Soil Data
Analysis of Legacy Data for Africa

Soil $pH_{\text{water}}$ (0-20 cm) for dominant soil component in Senegal and the Gambia (SOTWIS)

Source: ISRIC Report 2008 05.pdf
Towards Global Soil Information: activities within the GEO Task Global Soil Data
Conclusions

- GSIF is a framework for enhancing, collating, harmonizing, and use of soil and covariate data to:
  - storage/rescue of legacy data
  - assist production of added value global soil information at various resolutions

- using collaborative cooperation which brings in the required soil knowledge from local participants – Training @ ISRIC

- Components:
  - Soil Property Maps, OpenSoilProfile, Worldgrids.org
  - GSIF Packages, GSIF Manual

http://www.isric.org/services/training-and-education
Think globally – Act locally

We can do this – through collaboration and sharing of information