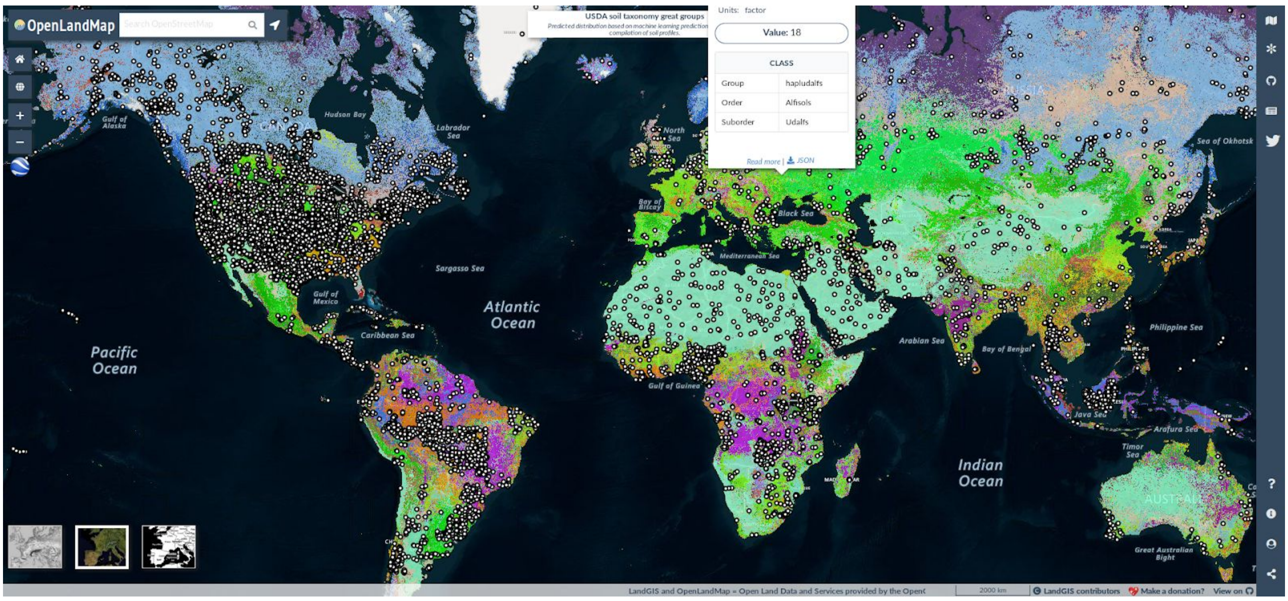
OpenLandMap.org: global gridded environmental layers based on ensemble Machine Learning

OpenLandMap.org (created and hosted by the OpenGeoHub foundation) provides access to global images on soil properties/classes, relief, geology, land cover/use/degradation, climate, current and potential vegetation, through a web-mapping interface allowing for interactive queries and overlays. OpenLandMap.org is the web-mapping component of the LandGIS system, which includes also REST API, R package (landmap) and Geonode installation with all layers. Current layers are available at 250 to 1000 m spatial resolutions. Purpose of OpenLandMap.org is to enable collaboration on developing new global spatial layers of importance for decision making, and especially of importance for the land restoration, forest management and nature conservation projects. This repository contains a snapshot of layers available via OpenLandMap.org, and prepared specifically for the Google Earth Engine users (see detailed processing steps to import these layers from cloud-optimized GeoTiFFs to Google Earth Engine).



Credits:

- Spatial layers and general functionality: OpenGeoHub foundation,
- Front-end and back-end optimization: GILAB, EnvirometriX,
- Import of layers to GEE: MultiOne,
- Global DEM derivatives: Yale University, Spatial-Ecology.net

Description of codes:

Open layers in Google Earth Engine:
https://code.earthengine.google.com/?asset=users/opengeohub/landgis

Table: Description of codes for the LandGIS layers.

Layer ID	Description	Units
DTM_SLOPE_MERIT-DEM_M	Slope in radians. Based on the MERIT DEM (Yamazaki et al. 2017) derived using SAGA GIS and Equi7 grid system.	radians
DTM_TWI_MERIT-DEM_M	SAGA Topographic Wetness Index (TWI). Based on the MERIT DEM (Yamazaki et al. 2017) derived using SAGA GIS and Equi7 grid system.	index
DTM_VBF_MERIT-DEM_M	Module Multiresolution Index of Valley Bottom Flatness (MRVBF). Based on the MERIT DEM (Yamazaki et al. 2017) derived using SAGA GIS and Equi7 grid system.	index
DTM_LITHOLOGY_USGS-ECOTAPESTRY_C	Rock type. Based on the USGS Global Ecophysiography map / Global Lithological Map database v1.1 (GLiM, Hartmann and Moosdorf, 2012).	factor
DTM_LANDFORM_USGS-ECOTAPESTRY_C	Landform class. Based on the USGS Global Ecophysiography map.	factor
DTM_EARTHQUAKES-DENS_EARTHQUAKE-USGS_M	Density of Earthquakes for the last 100 years. Based on the USGS global earthquakes database.	index
DTM_ASPECT-COSINE_MERIT-DEM_M	Cosine of the aspect. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset).	10,000 x index
DTM_ASPECT-SINE_MERIT-DEM_M	Sine of the aspect. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset).	10,000 x index
DTM_CONVERGENCE_MERIT-DEM_M	Convergence. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset), derived using GRASS GIS and Equi7 grid system.	100 x index
DTM_CTI_MERIT-DEM_M	Compound topographic index. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset), derived using GRASS GIS and Equi7 grid system.	1000 x index
DTM_DEV-MAGNITUDE_MERIT-DEM_M	Maximum multiscale deviation. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset), derived using WHITEBOX and Equi7 grid system.	10 x index
DTM_DEV-SCALE_MERIT-DEM_M	Scale of the maximum multiscale deviation. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset), derived using WHITEBOX and Equi7 grid system.	1 x index
DTM_EASTHNESS_MERIT-DEM_M	Easthness. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset).	10,000 x index
DTM_GEOM_MERIT-DEM_C	Geomorphon clasess. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset), derived using GRASS GIS and Equi7 grid system	factor

DTM_NORTHNESS_MERIT-DEM_M	Northness. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset).	10,000 x index
DTM_PCURV_MERIT-DEM_M	Profile curvature. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset), derived using GRASS GIS and Equi7 grid system	10^5 x index (1/m)
DTM_ROUGH-MAGNITUDE_MERIT-DEM_M	Maximum multiscale roughness. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset), derived using WHITEBOX and Equi7 grid system	100 x index
DTM_ROUGHNESS_MERIT-DEM_M	Roughness. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset).	10 x index
DTM_ROUGH-SCALE_MERIT-DEM_M	Scale of the maximum multiscale roughness. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset), derived using WHITEBOX and Equi7 grid system	1 x index
DTM_TCURV_MERIT-DEM_M	Tangential curvature. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset), derived using GRASS GIS and Equi7 grid system	10^5 x index (1/m)
DTM_VRM_MERIT-DEM_M	Vector ruggedness measure. Based on the MERIT DEM (Yamazaki et al. 2017) described in Amatulli et al. (2019; Geomorpho90m dataset), derived using GRASS GIS and Equi7 grid system	10^5 x index
LCV_WATER-OCCURENCE_JRC-SURFACEWATER_P	Surface water occurrence probability. Based on the Pekel et al. (2016).	probability
LCV_NIGHTLIGHTS-STABLE_DMSP-PC2_M	Nightlights changes. 2nd principal component based on the Version 4 DMSP-OLS Nighttime Lights Time Series 1997–2014.	index
LCV_LANDUSE-CROPLAND_HYDE_P	Croplands historic. Time-series of maps showing cropland evolution for the past 12,000 years based on the HYDE data set.	fraction
LCV_LANDUSE-PASTURE_HYDE_P	Pastures historic. Time-series of maps showing pastures evolution for the past 12,000 years based on the HYDE data set.	fraction
VEG_FAPAR_PROBA-V_D	FAPAR median monthly value 2014–2017. Based on the Copernicus PROB-V FAPAR product.	fraction
VEG_FAPAR_PROBA-V-ANNUAL_D	FAPAR median annual value 2014–2017. Based on the Copernicus PROB-V FAPAR product.	fraction
LDG_ORGANIC-CARBON-STOCK_MSA-KGM2_TD	Soil organic carbon stock change (0–30 cm). Estimated SOC loss based on the European Space Agency (ESA) Climate Change Initiative (ESACCI-LC) land cover maps 2001–2015.	kg / m2
LDG_FOREST-COVER_ESACCI-IFL_C	Tree-covered and intact forest landscapes. Based on the UNEP historic forest cover map, ESA land cover time series and intact forest landscape (IFL 2000, 2013 and 2016) data.	factor
LDG_LANDSCAPE-DEGRADATION_SIL-9KM_C	Landscape change trajectories. Based on the comparison of land cover changes in a 9 km search radius (produced by Space Informatics Lab, University of Cincinnati)	factor
CLM_LST_MOD11A2-DAY_M	Long-term Land Surface Temperature daytime monthly mean. MODIS MOD11A2 Land Surface Temperature daytime median value.	K / 0.02

CLM_LST_MOD11A2-DAY_SD	Long-term Land Surface Temperature daytime monthly sd. MODIS MOD11A2 Land Surface Temperature daytime sd value.	K / 0.02
CLM_LST_MOD11A2-DAYNIGHT_M	Long-term Land Surface Temperature monthly day-night difference. MODIS MOD11A2 Land Surface Temperature day-night difference.	K / 0.02
CLM_PRECIPITATION_IMERGE_M	Precipitation monthly in mm. Based on the Global Precipitation Measurement Integrated Multi-satellitE Retrievals for GPM (IMERG) 2014–2018 and WorldClim v2, CHELSA rainfall monthly images.	mm
SOL_GRTGROUP_USDA-SOILTAX_C	USDA soil taxonomy great groups. Predicted distribution based on machine learning predictions from global compilation of soil profiles.	factor
SOL_GRTGROUP_USDA-SOILTAX-HAPLUDALFS_P	Hapludalfs. Predicted distribution of the soils with argillic (clay accumulation) subsoil horizon.	fraction
SOL_ORGANIC-CARBON_USDA-6A1C_M	Soil organic carbon content in x 5 g / kg. Based on machine learning predictions from global compilation of soil profiles and samples.	x 5 g / kg
SOL_BULKDENS-FINEEARTH_USDA-4A1H_M	Soil bulk density in x 10 kg / m3. Based on machine learning predictions from global compilation of soil profiles and samples.	x 10 kg / m3
SOL_CLAY-WFRACTION_USDA-3A1A1A_M	Clay content in % (kg / kg). Based on machine learning predictions from global compilation of soil profiles and samples.	%
SOL_SAND-WFRACTION_USDA-3A1A1A_M	Sand content in % (kg / kg). Based on machine learning predictions from global compilation of soil profiles and samples.	%
SOL_TEXTURE-CLASS_USDA-TT_M	Soil texture class (USDA system). Derived using the predicted clay, silt and sand content images.	factor
SOL_PH-H2O_USDA-4C1A2A_M	Soil pH x 10 in H2O. Based on machine learning predictions from global compilation of soil profiles and samples.	index x 10
SOL_WATERCONTENT-33KPA_USDA-4B1C_M	Soil water content at 33kPa (field capacity). Based on machine learning predictions from global compilation of soil profiles and samples.	%
PNV_BIOME-TYPE_BIOME00K_C	Potential distribution of biomes. Potential Natural Vegetation biomes global predictions of classes (based on the BIOMES 6000 data set current biomes).	factor
PNV_FAPAR_PROBA-V_D	Potential FAPAR monthly. Potential Natural Vegetation FAPAR predicted monthly median (based on PROB-V FAPAR 2014–2017).	fraction
PNV_FAPAR_PROBA-V-ANNUAL_D	Potential FAPAR annual. Potential Natural Vegetation FAPAR predicted monthly median (based on PROB-V FAPAR 2014–2017).	fraction
PNV_FAPAR_PROBA-V-ANNUALDIFF_D	Difference potential vs actual FAPAR monthly. Derived as a difference between the predicted potential and actual Copernicus FAPAR 2014–2017.	fraction

Limitations:

LandGIS is designed as a globally consistent, data-driven automated soil mapping system that predicts vegetation indices, soil properties and classes using global covariates and globally fitted models. Accuracy of predictions is mainly determined by the density and quality of training points i.e. soil profiles and soil samples (read more about LandGIS). Considering that there are often large sampling gaps especially in northern latitudes, tropical forests, semi-arid zones and high elevations, predictions in these areas are also of limited accuracy (Cross-Validation R-square for soil properties between 0.45 and 0.75, for potential natural vegetation biomes about 0.75). We are therefore regularly updating predictions as the new training points are being entered into global compilation of training points. If you are looking for vegetation and soil information on national and/or local levels we advise you, before using LandGIS, to compare our predictions with national datasets and systems. If you discover an artifact or issue please report them.

Citation:

To cite specific layers please refer to the download page and DOI code e.g.:

- Hengl, T., (2018). Long-term MODIS LST day-time and night-time temperatures, sd and differences at 1 km based on the 2000–2017 time series (Version 1.0) [Data set]. Zenodo. http://doi.org/10.5281/zenodo.1435938

To learn more about Potential Vegetation Mapping, global soil mapping and DEM analysis please refer to:

- Amatulli G, McInerney D, Sethi T, Strobl P, Domisch S. (2019). Geomorpho90m - Global high-resolution geomorphometry layers: empirical evaluation and accuracy assessment. PeerJ Preprints 7:e27595v1 https://doi.org/10.7287/peerj.preprints.27595v1
- Hengl, T., Walsh, M.G., Sanderman, J., Wheeler, I., Harrison, S.P., Prentice, I.C., (2018). Global mapping of potential natural vegetation: an assessment of machine learning algorithms for estimating land potential. PeerJ 6:e5457 https://doi.org/10.7717/peerj.5457
- Hengl, T., MacMillan, R.A., (2019). Predictive Soil Mapping with R. OpenGeoHub foundation, Wageningen, the Netherlands, 370 pages, www.soilmapper.org, ISBN: 978-0-359-30635-0.

Data Availability:

OpenLandMap.org / LandGIS layers are available under the Open Database License (ODbl) v1.0 and can be downloaded from https://openlandmap.org and/or www.zenodo.org without restrictions. Access to LandGIS maps is also provided through a Web Coverage Service (WCS). Processing steps (R

and Python code) used to generate LandGIS layers is fully documented at:
https://github.com/Envirometrix/LandGISmaps

Support and bug reporting

To report a bug in LandGIS/OpenLandMap.org or request an enhancement, please use github issues.
To publish your global maps via OpenLandMap.org, please read these instructions.