# RiverATLAS Attributes (version 1.0)

(click hyperlinked ID to jump to individual information sheet)

| ID | Category | Attribute | Source Data | Citation | Column(s) | Count |
|---|---|---|---|---|---|---|
| H01 | Hydrology | Natural Discharge | WaterGAP v2.2 | Döll et al. 2003 | dis_m3_--- | x3 |
| H02 | Hydrology | Land Surface Runoff | WaterGAP v2.2 | Döll et al. 2003 | run_mm_--- | x1 |
| H03 | Hydrology | Inundation Extent | GIEMS-D15 | Fluet-Chouinard et al. 2015 | inu_pc_--- | x6 |
| H04 | Hydrology | Limnicity (Percent Lake Area) | HydroLAKES | Messager et al. 2016 | lka_pc_--- | x2 |
| H05 | Hydrology | Lake Volume | HydroLAKES | Messager et al. 2016 | lkv_mc_--- | x1 |
| H06 | Hydrology | Reservoir Volume | GRanD v1.1 | Lehner et al. 2011 | rev_mc_--- | x1 |
| H07 | Hydrology | Degree of Regulation | HydroSHEDS & GRanD | Lehner et al. 2011 | dor_pc_--- | x1 |
| H08 | Hydrology | River Area | HydroSHEDS & WaterGAP | Lehner & Grill 2013 | ria_ha_--- | x2 |
| H09 | Hydrology | River Volume | HydroSHEDS & WaterGAP | Lehner & Grill 2013 | riv_tc_--- | x2 |
| H10 | Hydrology | Groundwater Table Depth | Global Groundwater Map | Fan et al. 2013 | gwt_cm_--- | x1 |
| P01 | Physiography | Elevation | EarthEnv-DEM90 | Robinson et al. 2014 | ele_mt_--- | x4 |
| P02 | Physiography | Terrain Slope | EarthEnv-DEM90 | Robinson et al. 2014 | slp_dg_--- | x2 |
| P03 | Physiography | Stream Gradient | EarthEnv-DEM90 | Robinson et al. 2014 | sgr_dk_--- | x1 |
| C01 | Climate | Climate Zones | GEnS | Metzger et al. 2013 | clz_cl_--- | x1 |
| C02 | Climate | Climate Strata | GEnS | Metzger et al. 2013 | cls_cl_--- | x1 |
| C03 | Climate | Air Temperature | WorldClim v1.4 | Hijmans et al. 2005 | tmp_dc_--- | x16 |
| C04 | Climate | Precipitation | WorldClim v1.4 | Hijmans et al. 2005 | pre_mm_--- | x14 |
| C05 | Climate | Potential Evapotranspiration | Global-PET | Zomer et al. 2008 | pet_mm_--- | x14 |
| C06 | Climate | Actual Evapotranspiration | Global Soil-Water Balance | Trabucco & Zomer 2010 | aet_mm_--- | x14 |
| C07 | Climate | Global Aridity Index | Global Aridity Index | Zomer et al. 2008 | ari_ix_--- | x2 |
| C08 | Climate | Climate Moisture Index | WorldClim & Global-PET | Hijmans et al. 2005 | cmi_ix_--- | x14 |
| C09 | Climate | Snow Cover Extent | MODIS/Aqua | Hall & Riggs 2016 | snw_pc_--- | x15 |
| L01 | Landcover | Land Cover Classes | GLC2000 | Bartholomé & Belward 2005 | glc_cl_--- | x1 |
| L02 | Landcover | Land Cover Extent | GLC2000 | Bartholomé & Belward 2005 | glc_pc_--- | x44 |
| L03 | Landcover | Potential Natural Vegetation Classes | EarthStat | Ramankutty & Foley 1999 | pnv_cl_--- | x1 |
| L04 | Landcover | Potential Natural Vegetation Extent | EarthStat | Ramankutty & Foley 1999 | pnv_pc_--- | x30 |
| L05 | Landcover | Wetland Classes | GLWD | Lehner & Döll 2004 | wet_cl_--- | x1 |
| L06 | Landcover | Wetland Extent | GLWD | Lehner & Döll 2004 | wet_pc_--- | x22 |
| L07 | Landcover | Forest Cover Extent | GLC2000 | Bartholomé & Belward 2005 | for_pc_--- | x2 |
| L08 | Landcover | Cropland Extent | EarthStat | Ramankutty et al. 2008 | crp_pc_--- | x2 |
| L09 | Landcover | Pasture Extent | EarthStat | Ramankutty et al. 2008 | pst_pc_--- | x2 |
| L10 | Landcover | Irrigated Area Extent (Equipped) | HID v1.0 | Siebert et al. 2015 | ire_pc_--- | x2 |
| L11 | Landcover | Glacier Extent | GLIMS | GLIMS & NSIDC 2012 | gla_pc_--- | x2 |
| L12 | Landcover | Permafrost Extent | PZI | Gruber 2012 | prm_pc_--- | x2 |
| L13 | Landcover | Protected Area Extent | WDPA | IUCN & UNEP-WCMC 2014 | pac_pc_--- | x2 |
| L14 | Landcover | Terrestrial Biomes | TEOW | Dinerstein et al. 2017 | tbi_cl_--- | x1 |
| L15 | Landcover | Terrestrial Ecoregions | TEOW | Dinerstein et al. 2017 | tec_cl_--- | x1 |
| L16 | Landcover | Freshwater Major Habitat Types | FEOW | Abell et al. 2008 | fmh_cl_--- | x1 |
| L17 | Landcover | Freshwater Ecoregions | FEOW | Abell et al. 2008 | fec_cl_--- | x1 |
| S01 | Soils & Geology | Clay Fraction in Soil | SoilGrids1km | Hengl et al. 2014 | cly_pc_--- | x2 |
| S02 | Soils & Geology | Silt Fraction in Soil | SoilGrids1km | Hengl et al. 2014 | slt_pc_--- | x2 |
| S03 | Soils & Geology | Sand Fraction in Soil | SoilGrids1km | Hengl et al. 2014 | snd_pc_--- | x2 |
| S04 | Soils & Geology | Organic Carbon Content in Soil | SoilGrids1km | Hengl et al. 2014 | soc_th_--- | x2 |
| S05 | Soils & Geology | Soil Water Content | Global Soil-Water Balance | Trabucco & Zomer 2010 | swc_pc_--- | x14 |
| S06 | Soils & Geology | Lithological Classes | GLiM | Hartmann & Moosdorf 2012 | lit_cl_--- | x1 |
| S07 | Soils & Geology | Karst Area Extent | Rock Outcrops v3.0 | Williams & Ford 2006 | kar_pc_--- | x2 |
| S08 | Soils & Geology | Soil Erosion | GloSEM v1.2 | Borrelli et al. 2017 | ero_kh_--- | x2 |
| A01 | Anthropogenic | Population Count | GPW v4 | CIESIN 2016 | pop_ct_--- | x2 |
| A02 | Anthropogenic | Population Density | GPW v4 | CIESIN 2016 | ppd_pk_--- | x2 |
| A03 | Anthropogenic | Urban Extent | GHS S-MOD v1.0 (2016) | Pesaresi & Freire 2016 | urb_pc_--- | x2 |
| A04 | Anthropogenic | Nighttime Lights | Nighttime Lights v4 | Doll 2008 | nli_ix_--- | x2 |
| A05 | Anthropogenic | Road Density | GRIP v4 | Meijer et al. 2018 | rdd_mk_--- | x2 |
| A06 | Anthropogenic | Human Footprint | Human Footprint v2 | Venter et al. 2016 | hft_ix_--- | x4 |
| A07 | Anthropogenic | Global Administrative Areas | GADM v2.0 | University of Berkeley 2012 | gad_id_--- | x1 |
| A08 | Anthropogenic | Gross Domestic Product | GDP PPP v2 | Kummu et al. 2018 | gdp_ud_--- | x3 |
| A09 | Anthropogenic | Human Development Index | HDI v2 | Kummu et al. 2018 | hdi_ix_--- | x1 |
| | **Total** | **Variables: 56** | | | **Attributes:** | **281** |

| | | | |
|---|---|---|---|
| ***Category*** | Hydrology | ID-H01 | ***>>> Back to Attribute List*** |

# *Attribute* Natural Discharge

***Source data*** WaterGAP v2.2 (data of 2014)

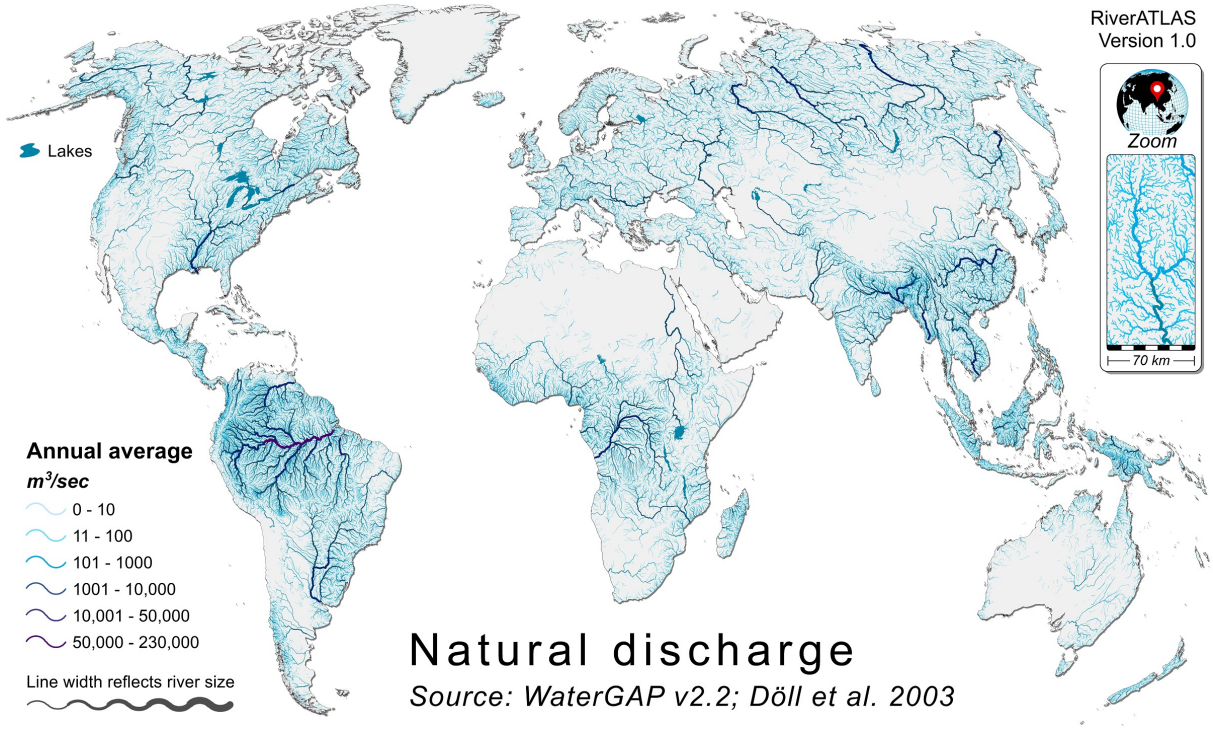
***Citation:*** Döll et al. 2003 ***Native format:*** 15 arc-second grid ***Units:*** cubic meters/second

***Column name*** **dis_m3_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {p} at reach pour point

***Dimension {oo}:*** {yr} annual average | {mn} annual minimum | {mx} annual maximum

***Existing suffixes {xoo}:*** pyr | pmn | pmx




| | |
|---|---|
| ***Data description*** | Discharge and runoff estimates for HydroATLAS are based on long-term (1971–2000) average 'naturalized' discharge and runoff values provided by the state-of-the-art global integrated water balance model WaterGAP (Döll et al. 2003, model version 2.2 as of 2014). The WaterGAP data were spatially downscaled from their original 0.5 degree pixel resolution (~50 km at the equator) to the 15 arc-second (~500 m) resolution of the HydroSHEDS river network using geo-statistical techniques (Lehner and Grill 2013). Preliminary tests against approximately 3000 global gauging stations indicate a good overall correlation for the long-term averages, but also reveal larger uncertainties, in particular in the minimum and maximum statistics, for areas that are dominated by snow, glaciers, wetlands, and (semi-)arid conditions. |
| ***Reference*** | Döll, P., Kaspar, F., Lehner, B. (2003). A global hydrological model for deriving water availability indicators: model tuning and validation. Journal of Hydrology, 270, 105-134. |
| ***Website*** | http://www.watergap.de/ |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | Annual minimum and maximum discharges were derived from the 12 long-term average monthly flow values (1971-2000), i.e. they represent the flow of the lowest or highest month within the average year. Additional reading: Lehner, B., Grill G. (2013). Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. Hydrological Processes, 27(15), 2171-2186. doi: 10.1002/hyp.9740. |

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|---|---|---|---|
| ***Category*** | Hydrology | ID-H02 | ***>>> Back to Attribute List*** |

## *Attribute* Land Surface Runoff

***Source data*** WaterGAP v2.2 (data of 2014)

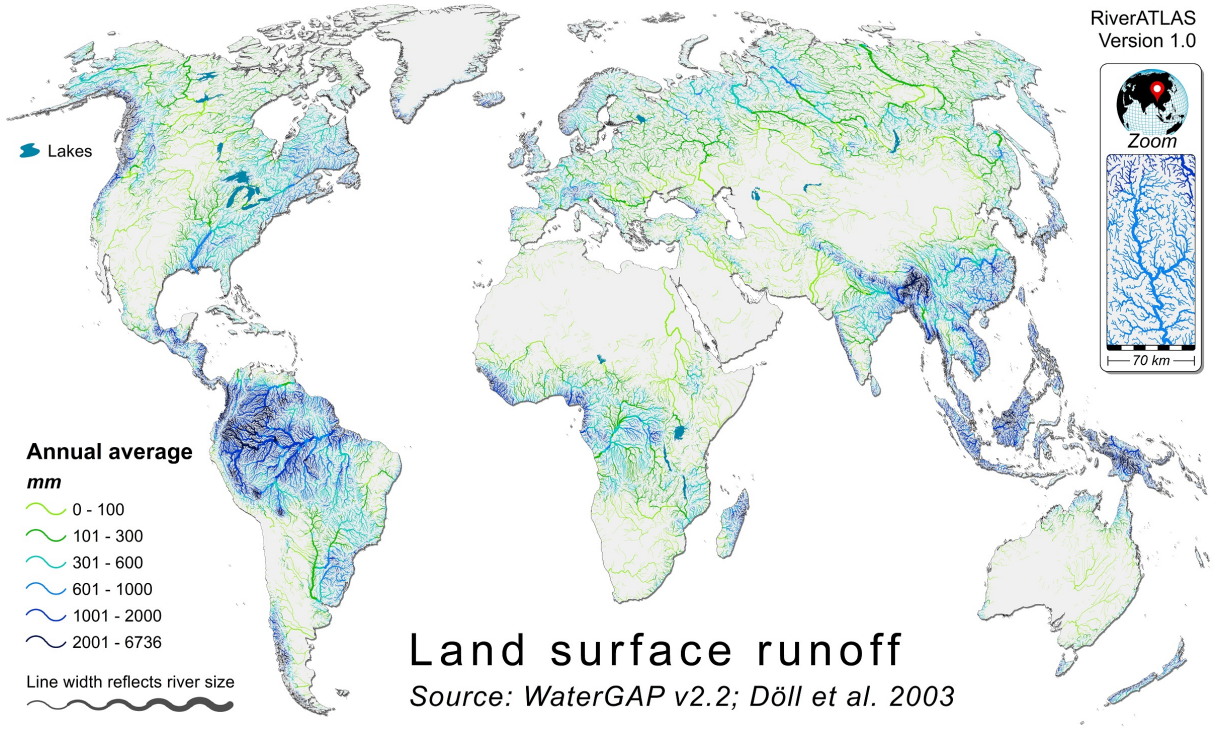
***Citation:*** Döll et al. 2003 ***Native format:*** 15 arc-second grid ***Units:*** millimeters

***Column name*** **run_mm_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {yr} annual average

***Existing suffixes {xoo}:*** cyr




| | |
|---|---|
| ***Data description*** | Discharge and runoff estimates for HydroATLAS are based on long-term (1971–2000) average 'naturalized' discharge and runoff values provided by the state-of-the-art global integrated water balance model WaterGAP (Döll et al. 2003, model version 2.2 as of 2014). The WaterGAP data were spatially downscaled from their original 0.5 degree pixel resolution (~50 km at the equator) to the 15 arc-second (~500 m) resolution of the HydroSHEDS river network using geo-statistical techniques (Lehner and Grill 2013). Preliminary tests against approximately 3000 global gauging stations indicate a good overall correlation for the long-term averages, but also reveal larger uncertainties for areas that are dominated by snow, glaciers, wetlands, and (semi-)arid conditions. |
| ***Reference*** | Döll, P., Kaspar, F., Lehner, B. (2003). A global hydrological model for deriving water availability indicators: model tuning and validation. Journal of Hydrology, 270, 105-134. |
| ***Website*** | http://www.watergap.de/ |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | Further reading: Lehner, B., Grill G. (2013). Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. Hydrological Processes, 27(15), 2171-2186. doi: 10.1002/hyp.9740. |

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|---|---|---|---|
| ***Category*** | Hydrology | ID-H03 | ***>>> Back to Attribute List*** |

## *Attribute* Inundation Extent

***Source data*** Global Inundation Extent from Multi-Satellites (GIEMS-D15)

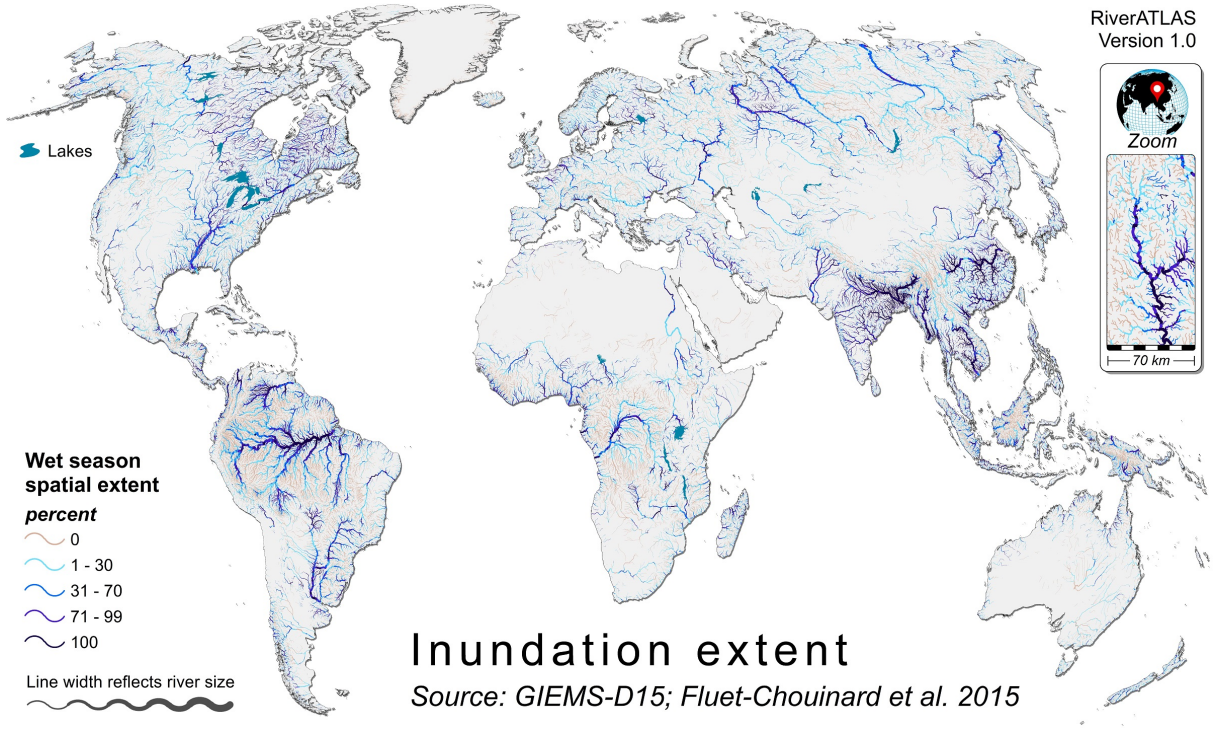
***Citation:*** Fluet-Chouinard et al. 2015 ***Native format:*** 15 arc-second grid ***Units:*** percent cover

***Column name*** **inu_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {mn} annual minimum | {mx} annual maximum | {lt} long-term maximum

***Existing suffixes {xoo}:*** cmn | cmx | clt | umn | umx | ult




| | |
|---|---|
| ***Data description*** | GIEMS-D15 is a high-resolution global inundation map at a pixel size of 15 arc-seconds (approximately 500m at the equator). The map was generated by downscaling inundated area estimates from the Global Inundation Extent from Multi-Satellites (GIEMS, Prigent et al. 2007) for the years 1993-2004, and bias-adjusting them with wetland extents from the Global Lakes and Wetlands Database (GLWD, Lehner and Döll 2004). GIEMS-D15 represents three states of land surface inundation extents: mean annual minimum (permanently inundated), mean annual maximum (seasonally inundated), and long-term maximum (areas affected by extreme flood events). |
| ***Reference*** | Fluet-Chouinard, E., Lehner, B., Rebelo, L. M., Papa, F., & Hamilton, S. K. (2015). Development of a global inundation map at high spatial resolution from topographic downscaling of coarse-scale remote sensing data. Remote Sensing of Environment, 158, 348-361. |
| ***Website*** | http://www.estellus.fr/index.php?static13/giems-d15 |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | Further readings: Prigent, C., Papa, F., Aires, F., Rossow, W.B., Matthews, E. (2007). Global inundation dynamics inferred from multiple satellite observations, 1993-2000. Journal of Geophysical Research, 112(D12107), 1-13. Lehner, B., Döll, P. (2004). Development and validation of a global database of lakes, reservoirs and wetlands. Journal of Hydrology, 296(1), 1-22. |

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|---|---|---|---|
| ***Category*** | Hydrology | ID-H04 | ***>>> Back to Attribute List*** |

# *Attribute* Limnicity (Percent Lake Area)

***Source data*** HydroLAKES

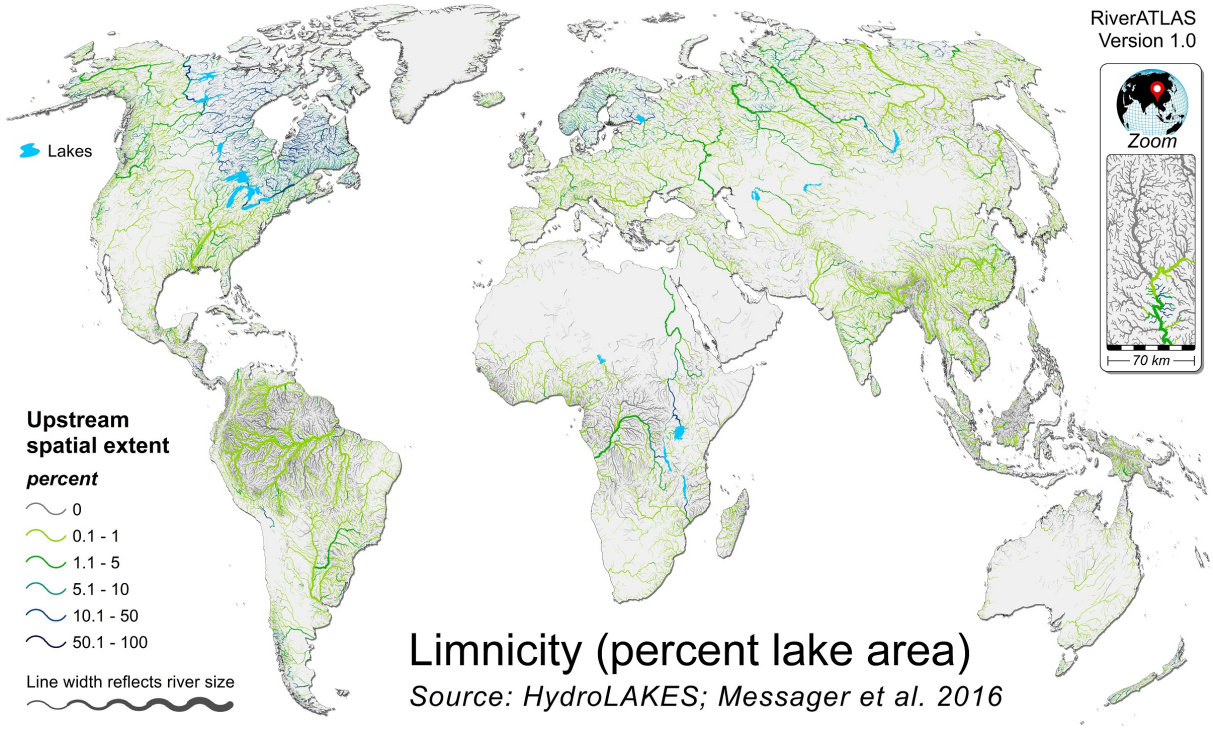
***Citation:*** Messager et al. 2016 ***Native format:*** Polygons ***Units:*** percent cover (x10)

***Column name*** **lka_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {se} spatial extent (%)

***Existing suffixes {xoo}:*** cse | use




| | |
|---|---|
| ***Data description*** | HydroLAKES is a database aiming to provide the shoreline polygons of all global lakes and reservoirs with a surface area of at least 10 ha. Attributes for each of the 1.42 million lakes include estimates of the shoreline length, average depth, water volume and residence time. All lakes are co-registered to the global river network of the HydroSHEDS database via their lake pour points. The volume of most lakes is estimated based on the surrounding terrain information using a geostatistical model. Limnicity is defined as the percent lake area in the given spatial unit. |
| ***Reference*** | Messager, M.L., Lehner, B., Grill, G., Nedeva, I., Schmitt, O. (2016). Estimating the volume and age of water stored in global lakes using a geo-statistical approach. Nature Communications, 7, 13603. doi: 10.1038/ncomms13603 |
| ***Website*** | http://www.hydrosheds.org/page/hydrolakes |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | In the stored data, percent values are multiplied by 10 (i.e. value 10 means 1%). |

| | | | |
|---|---|---|---|
| ***Category*** | Hydrology | ID-H05 | ***>>> Back to Attribute List*** |

## *Attribute* Lake Volume

***Source data*** HydroLAKES

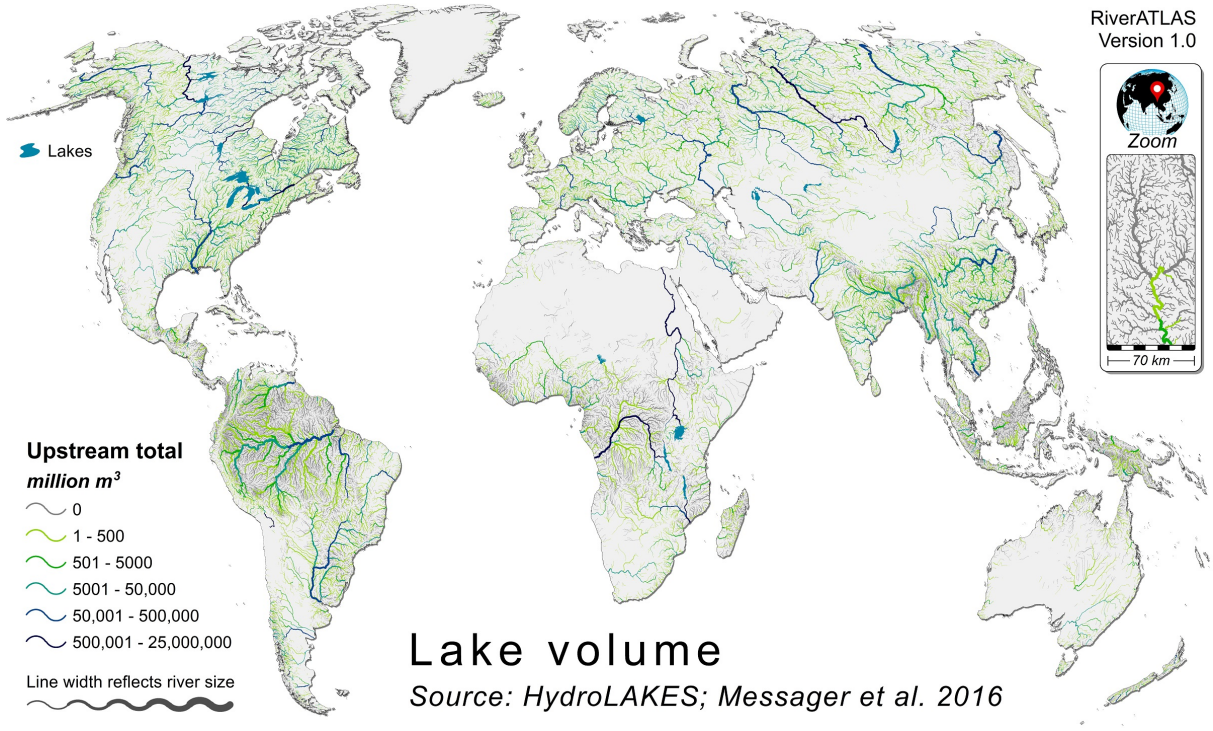
***Citation:*** Messager et al. 2016 ***Native format:*** Polygons ***Units:*** million cubic meters

***Column name*** **lkv_mc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {su} sum

***Existing suffixes {xoo}:*** usu




| | |
|---|---|
| ***Data description*** | HydroLAKES is a database aiming to provide the shoreline polygons of all global lakes and reservoirs with a surface area of at least 10 ha. Attributes for each of the 1.42 million lakes include estimates of the shoreline length, average depth, water volume and residence time. All lakes are co-registered to the global river network of the HydroSHEDS database via their lake pour points. The volume of most lakes is estimated based on the surrounding terrain information using a geostatistical model. |
| ***Reference*** | Messager, M.L., Lehner, B., Grill, G., Nedeva, I., Schmitt, O. (2016). Estimating the volume and age of water stored in global lakes using a geo-statistical approach. Nature Communications, 7, 13603. doi: 10.1038/ncomms13603 |
| ***Website*** | http://www.hydrosheds.org/page/hydrolakes |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | None |

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|---|---|---|---|
| ***Category*** | Hydrology | ID-H06 | ***>>> Back to Attribute List*** |

# *Attribute* Reservoir Volume

***Source data*** Global Reservoir and Dams (GRanD) database v1.1

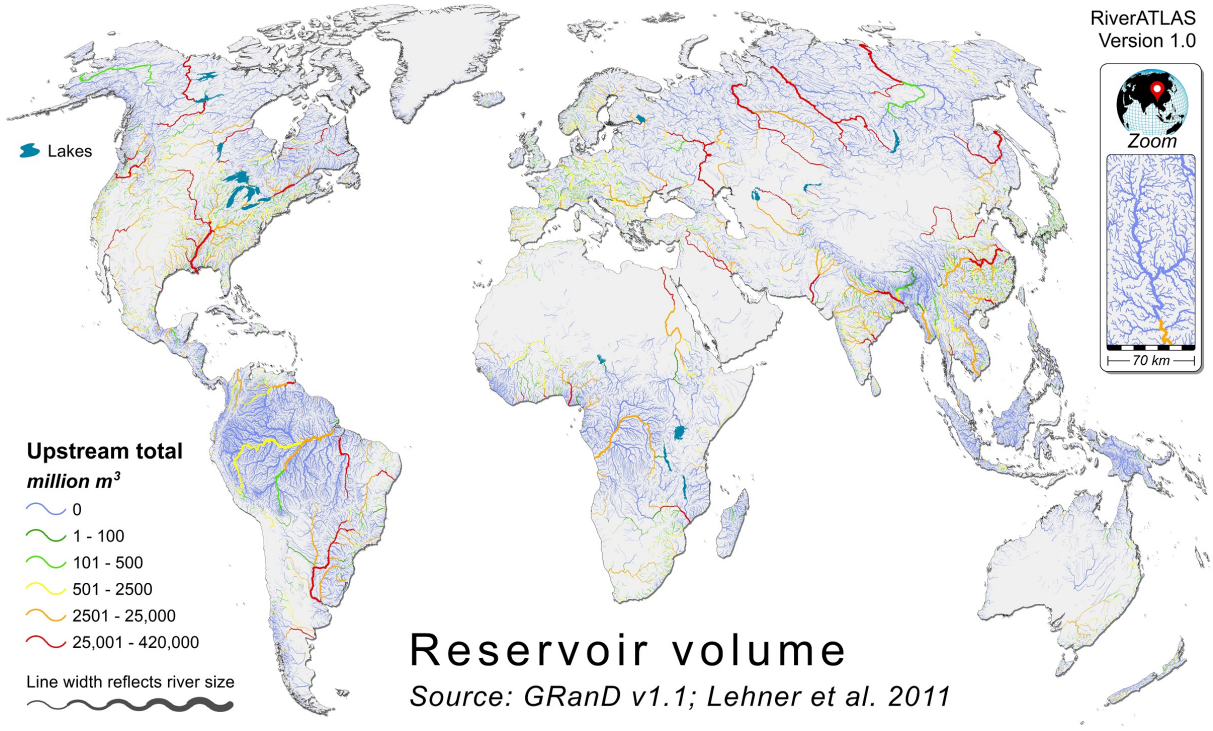
***Citation:*** Lehner et al. 2011 ***Native format:*** Polygons ***Units:*** million cubic meters

***Column name*** **rev_mc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {su} sum

***Existing suffixes {xoo}:*** usu

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|---|---|
| ***Data description*** | The Global Reservoir and Dam (GranD) database, version 1.1, contains 6,862 records of reservoirs and their associated dams with a cumulative storage capacity of 6,197 km3. The dams were geospatially referenced and assigned to polygons depicting reservoir outlines at high spatial resolution. Dams have multiple attributes, including reservoir area and volume. While the main focus was to include all dams associated with reservoirs that have a storage capacity of at least 0.1 km3, smaller dams and reservoirs were added where data were available. The data were compiled by an international research team on behalf of the Global Water System Project (GWSP). |
| ***Reference*** | Lehner, B., Reidy Liermann, C., Revenga, C., Vörösmarty, C., Fekete, B., Crouzet, P., ... & Wisser, D. (2011). High- resolution mapping of the world's reservoirs and dams for sustainable river-flow management. Frontiers in Ecology and the Environment, 9(9), 494-502. |
| ***Website*** | https://sedac.ciesin.columbia.edu/data/collection/grand-v1 |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | The calculations used all dams from GRanD v1.1 except those attributed as "unknown capacity", "planned", "destroyed", "under construction" yet with unknown year of completion, and "unreliable quality". Also, Lake Victoria was excluded as it is a lake regulation structure that is not operated at full capacity. This left 6,778 out of all 6,862 original GRanD reservoirs. |

| | | | |
|---|---|---|---|
| ***Category*** | Hydrology | ID-H07 | ***>>> Back to Attribute List*** |

## *Attribute* Degree of Regulation

***Source data*** HydroSHEDS and Global Reservoir and Dams (GRanD) database v1.1

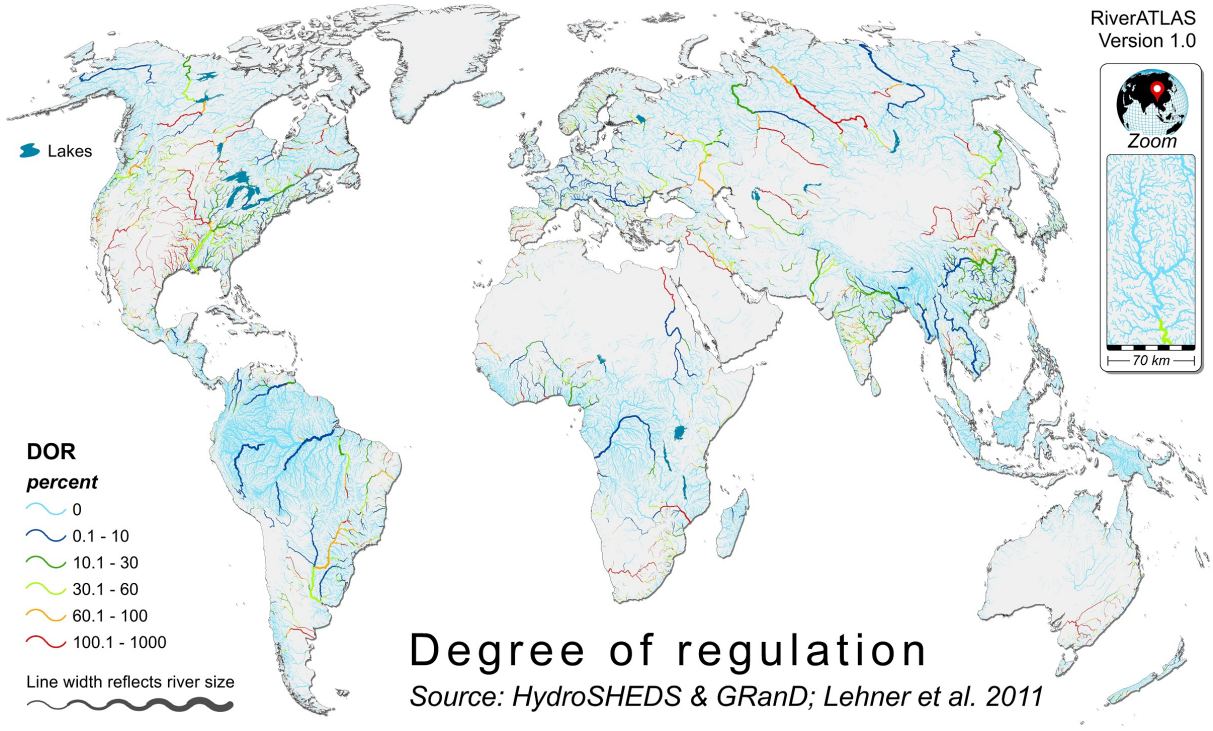
***Citation:*** Lehner et al. 2011 ***Native format:*** Polygons ***Units:*** percent (x10)

***Column name*** **dor_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {p} at reach pour point

***Dimension {oo}:*** {va} value

***Existing suffixes {xoo}:*** pva




| | |
|---|---|
| ***Data description*** | The Degree of Regulation (DOR) provides an index of how strongly a dam or set of dams can affect the natural flow regime of downstream river reaches. DOR for a river reach is calculated as the percent ratio between the total reservoir storage volume of all dams on or upstream of the reach and the the total annual discharge volume available at the reach (using attributes H01 and H06). A high DOR value indicates an increased probability that substantial flow volumes can be stored throughout a given year and released at later times. A DOR value of 100% means that the entire annual flow can be stored, and values larger than 100% indicate multi-year storage capacities. Note that DOR values were capped at a maximum of 1000% assuming that higher estimates are likely outliers or errors. |
| ***Reference*** | Lehner, B., Reidy Liermann, C., Revenga, C., Vörösmarty, C., Fekete, B., Crouzet, P., ... & Wisser, D. (2011). High- resolution mapping of the world's reservoirs and dams for sustainable river-flow management. Frontiers in Ecology and the Environment, 9(9), 494-502. |
| ***Website*** | https://sedac.ciesin.columbia.edu/data/collection/grand-v1 |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | In the stored data, percent values are multiplied by 10 (i.e. value 10 means 1%). The calculations used all dams from GRanD v1.1 except those attributed as "unknown capacity", "planned", "destroyed", "under construction" yet with unknown year of completion, and "unreliable quality". Also, Lake Victoria was excluded as it is a lake regulation structure that is not operated at full capacity. This left 6,778 out of all 6,862 original GRanD reservoirs. |

| | | | |
|---|---|---|---|
| ***Category*** | Hydrology | ID-H08 | ***>>> Back to Attribute List*** |

## *Attribute* River Area

***Source data*** HydroSHEDS and WaterGAP v2.2

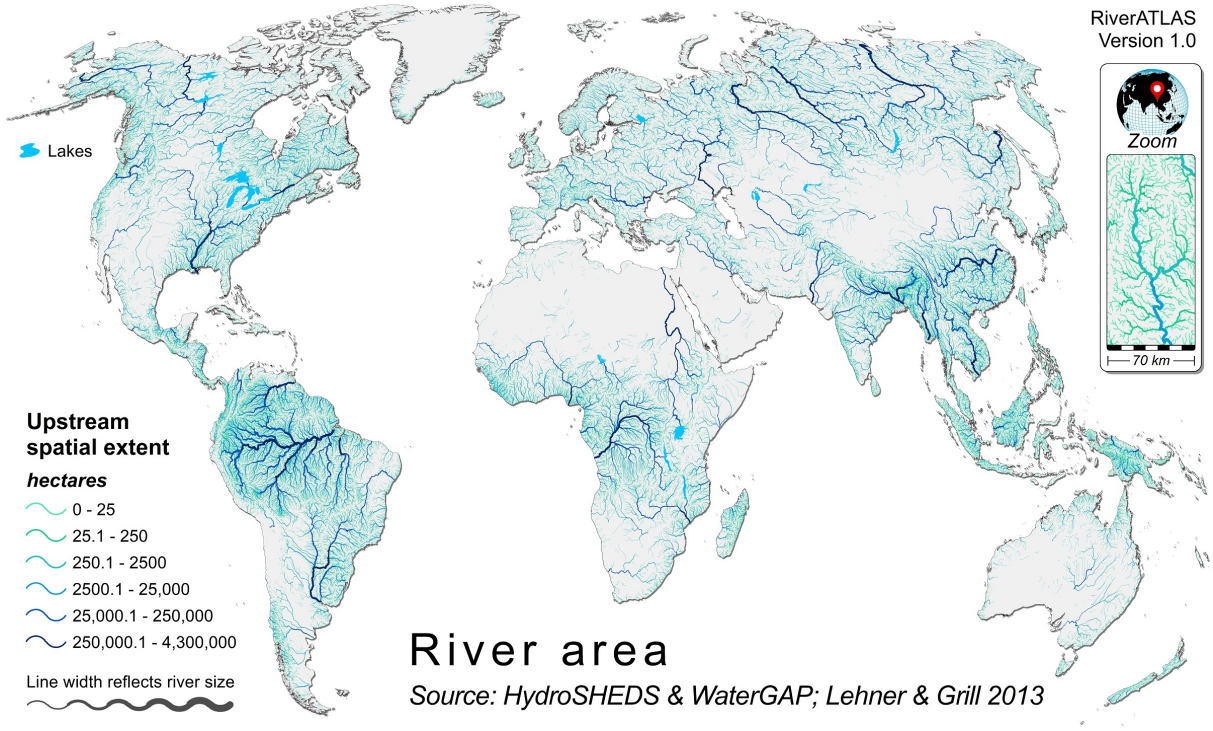
***Citation:*** Lehner & Grill 2013 ***Native format:*** 15 arc-second grid ***Units:*** hectares

***Column name*** **ria_ha_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {r} along reach segment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {su} sum

***Existing suffixes {xoo}:*** rsu | usu




| | |
|---|---|
| ***Data description*** | River area was calculated using the the HydroSHEDS database at 15 arc-second resolution. HydroSHEDS was derived from high-resolution (3 arc-second) elevation data obtained during NASA's Shuttle Radar Topography Mission (SRTM) in February 2000. Based on global discharge estimates and simple hydraulic geometry laws (Allen et al. 1994), a first-level approximation of the dimensions of channel width was derived for every river reach of the HydroSHEDS database. For discharge, the long-term (1971-2000) monthly maximum was used (see attribute H01) as a proxy to represent bankfull flow. The surface area of every river reach was then calculated by multiplying channel width and length. |
| ***Reference*** | Lehner, B., Grill G. (2013). Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. Hydrological Processes, 27(15), 2171-2186. doi: 10.1002/hyp.9740. |
| ***Website*** | http://www.hydrosheds.org/ |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | Further reading: Allen, P.M., Arnold, J.C., Byars, B.W. (1994). Downstream channel geometry for use in planning-level models. JAWRA Journal of the American Water Resources Association, 30, 663-671. doi:10.1111/j.1752-1688.1994.tb03321.x |

| | | | |
|---|---|---|---|
| ***Category*** | Hydrology | ID-H09 | ***>>> Back to Attribute List*** |

# *Attribute* River Volume

***Source data*** HydroSHEDS and WaterGAP v2.2

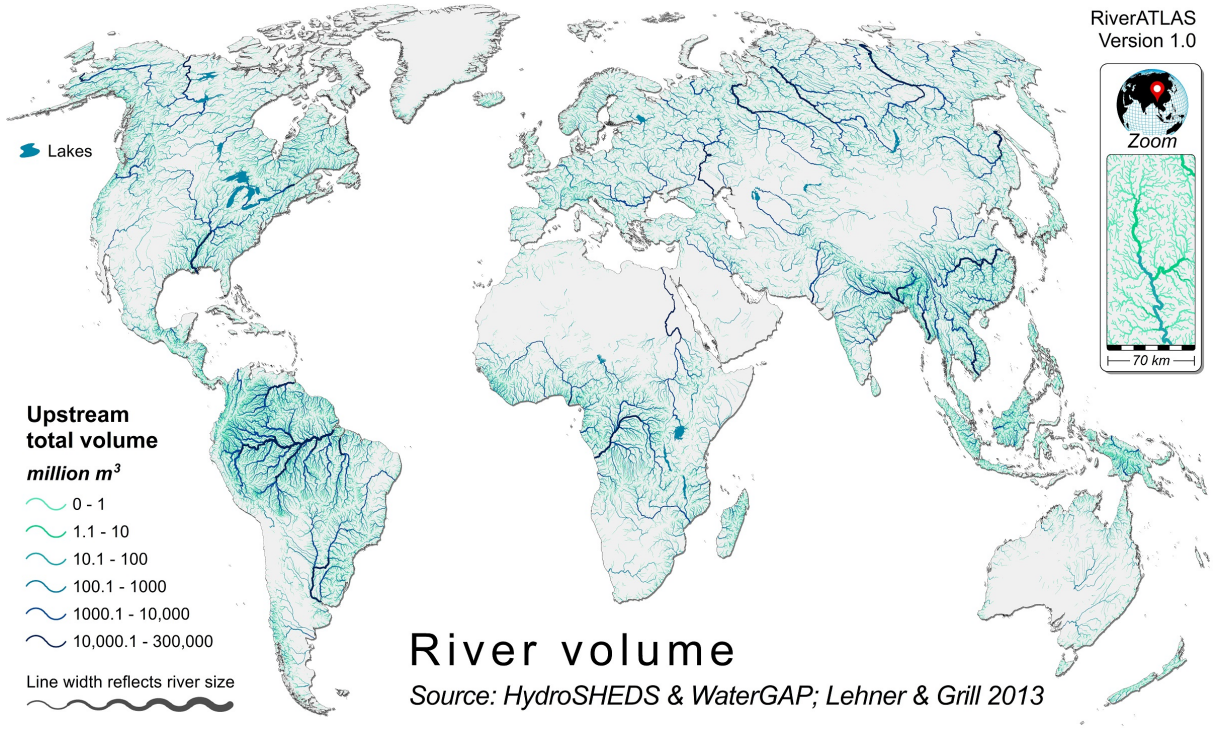
***Citation:*** Lehner & Grill 2013 ***Native format:*** 15 arc-second grid ***Units:*** thousand cubic meters

***Column name*** **riv_tc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {r} along reach segment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {su} sum

***Existing suffixes {xoo}:*** rsu | usu




| | |
|---|---|
| ***Data description*** | River volume was calculated using the the HydroSHEDS database at 15 arc-second resolution. HydroSHEDS was derived from high-resolution (3 arc-second) elevation data obtained during NASA's Shuttle Radar Topography Mission (SRTM) in February 2000. Based on global discharge estimates and simple hydraulic geometry laws (Allen et al. 1994), a first-level approximation of the dimensions of channel width and depth was derived for every river reach of the HydroSHEDS database. For discharge, the long-term (1971-2000) monthly maximum was used (see attribute H01) as a proxy to represent bankfull flow. The water volume per river reach was then calculated by multiplying channel width, depth, and length. |
| ***Reference*** | Lehner, B., Grill G. (2013). Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. Hydrological Processes, 27(15), 2171-2186. doi: 10.1002/hyp.9740. |
| ***Website*** | http://www.hydrosheds.org/ |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | Further reading: Allen, P.M., Arnold, J.C., Byars, B.W. (1994). Downstream channel geometry for use in planning-level models. JAWRA Journal of the American Water Resources Association, 30, 663-671. doi:10.1111/j.1752-1688.1994.tb03321.x |

| | | | |
|---|---|---|---|
| ***Category*** | Hydrology | ID-H10 | ***>>> Back to Attribute List*** |

# ***Attribute*** Groundwater Table Depth

***Source data*** Global Groundwater Map

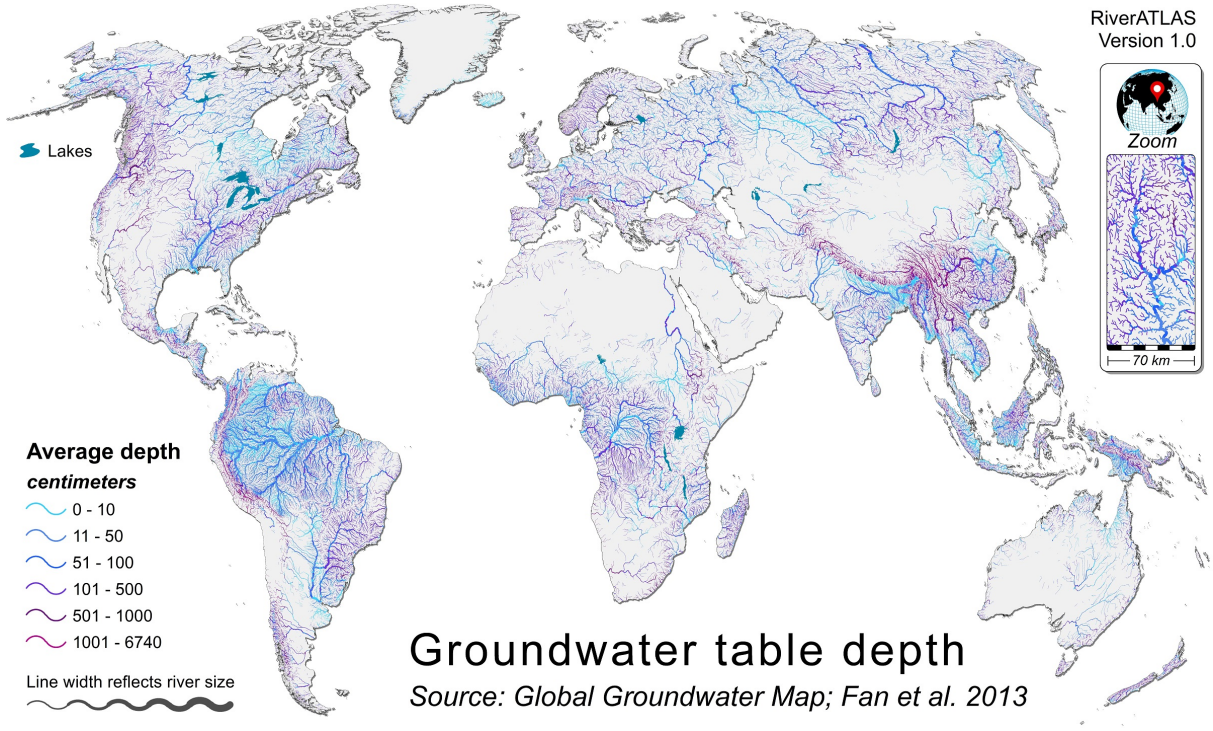
***Citation:*** Fan et al. 2013 ***Native format:*** 30 arc-second grid ***Units:*** centimeters

***Column name*** **gwt_cm_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** cav




| | |
|---|---|
| ***Data description*** | Fan et al. (2013) compiled global observations of water table depth from government archives and literature (including years 1927-2009), and then filled in data gaps and infered patterns and processes using a groundwater model forced by modern climate, terrain, and sea level. Patterns in water table depth explain patterns in wetlands at the global scale and vegetation gradients at regional and local scales. Overall, shallow groundwater influences 22 to 32% of global land area, including ~15% as groundwater-fed surface water features and 7 to 17% of the water table or its capillary fringe within plant rooting depths. |
| ***Reference*** | Fan, Y., Li, H., & Miguez-Macho, G. (2013). Global patterns of groundwater table depth. Science, 339(6122), 940-943. |
| ***Website*** | http://science.sciencemag.org/content/339/6122/940 |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | None |

| | | | |
|---|---|---|---|
| ***Category*** | Physiography | ID-P01 | ***>>> Back to Attribute List*** |

## *Attribute* Elevation

***Source data*** EarthEnv-DEM90

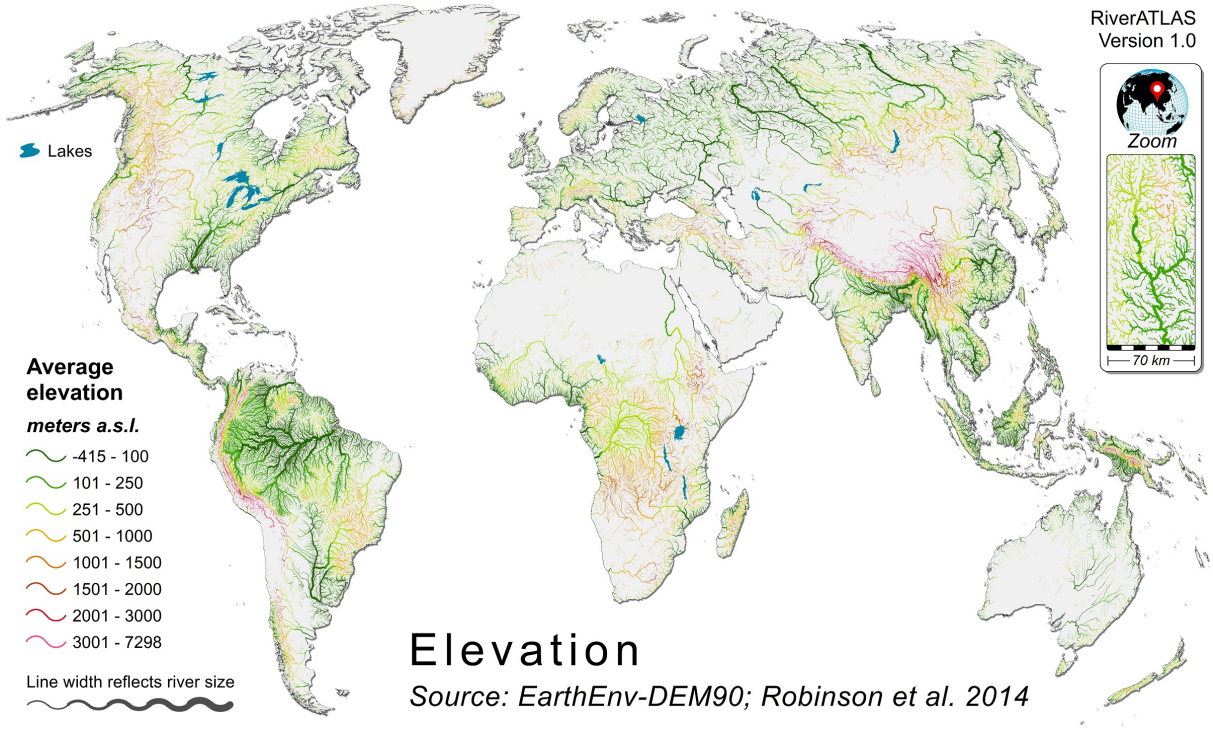
***Citation:*** Robinson et al. 2014 ***Native format:*** 3 arc-second grid ***Units:*** meters a.s.l.

***Column name*** **ele_mt_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {av} average | {mn} minimum | {mx} maximum

***Existing suffixes {xoo}:*** cav | cmn | cmx | uav




| | |
|---|---|
| ***Data description*** | EarthEnv-DEM90 is a digital elevation model that provides elevation values for a pixel resolution of 3 arc-seconds (approximately 90m at the equator). It is derived from CGIAR-CSI SRTM v4.1 and ASTER GDEM v2 data products representing conditions of 2000-2010. These data have been processed and merged to provide a continuous coverage between 60˚S and 83˚N. For inclusion in HydroATLAS, the original values were first aggregated into a 15 arc-second resolution using the 'mean' statistic. |
| ***Reference*** | Robinson, N., Regetz, J., Guralnick, R.P. (2014). EarthEnv-DEM90: A nearly-global, void-free, multi-scale smoothed, 90m digital elevation model from fused ASTER and SRTM data. ISPRS Journal of Photogrammetry and Remote Sensing, 87, 57-67. doi: 10.1016/j.isprsjprs.2013.11.002. |
| ***Website*** | http://www.earthenv.org/DEM |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | None |

| | | | |
|---|---|---|---|
| ***Category*** | Physiography | ID-P02 | ***>>> Back to Attribute List*** |

# *Attribute* Terrain Slope

***Source data*** EarthEnv-DEM90

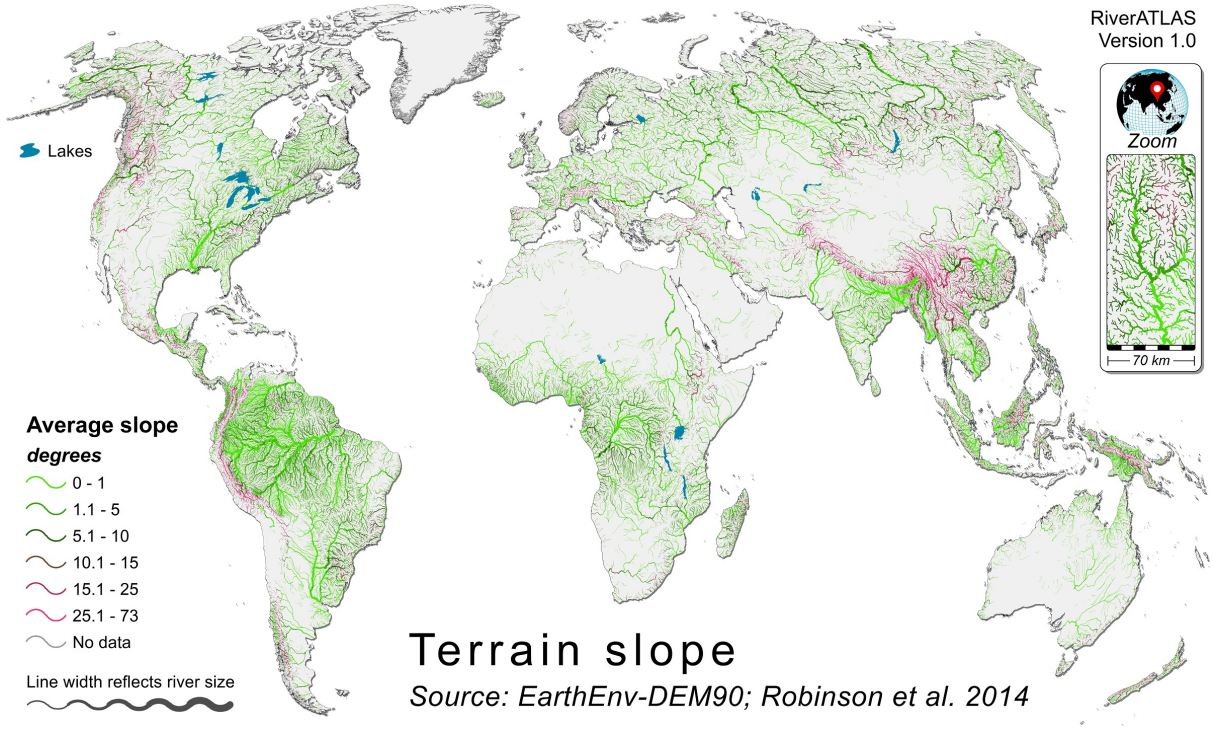
***Citation:*** Robinson et al. 2014 ***Native format:*** 3 arc-second grid ***Units:*** degrees (x10)

***Column name*** **slp_dg_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** cav | uav




| | |
|---|---|
| ***Data description*** | EarthEnv-DEM90 is a digital elevation model that provides elevation values for a pixel resolution of 3 arc-seconds (approximately 90m at the equator). It is derived from CGIAR-CSI SRTM v4.1 and ASTER GDEM v2 data products, representing conditions of 2000-2010. These data have been processed and merged to provide a continuous coverage between 60˚S and 83˚N. Slope values were computed at 3 arc-second resolution based on Horn's method with latitudinal corrections for the distortion in the XY spacing of geographic coordinates by approximating the geodesic distance between cell centers. For inclusion in HydroATLAS, the high-resolution results were first aggregated into a 15 arc-second resolution using the 'mean' statistic. |
| ***Reference*** | Robinson, N., Regetz, J., Guralnick, R.P. (2014). EarthEnv-DEM90: A nearly-global, void-free, multi-scale smoothed, 90m digital elevation model from fused ASTER and SRTM data. ISPRS Journal of Photogrammetry and Remote Sensing, 87, 57-67. doi: 10.1016/j.isprsjprs.2013.11.002. |
| ***Website*** | http://www.earthenv.org/DEM |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | In the stored data, degree values are multiplied by 10 (i.e. value 10 means 1 degree). NoData values (-9999) were assigned to all of Greenland because calculated slopes were not within reasonable ranges due to substantial outliers in DEM over the Greenland ice sheet. |

| | | | |
|---|---|---|---|
| ***Category*** | Physiography | ID-P03 | ***>>> Back to Attribute List*** |

# *Attribute* Stream Gradient

***Source data*** EarthEnv-DEM90

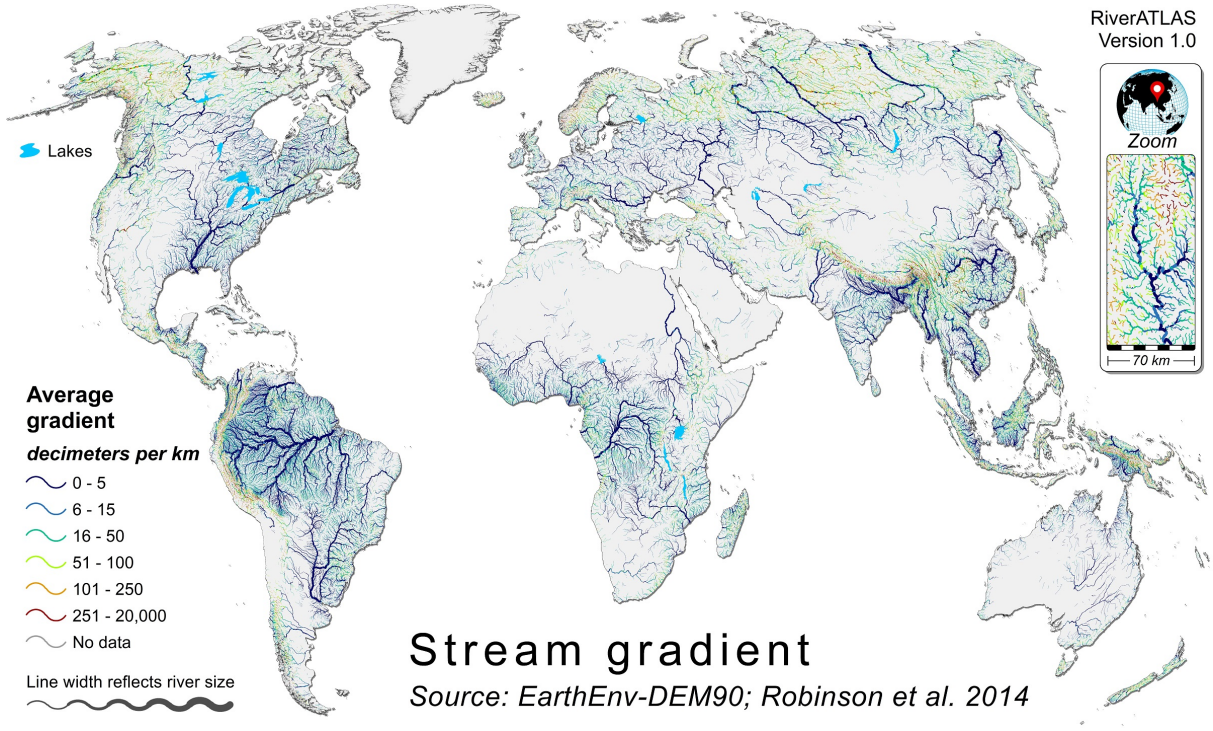
***Citation:*** Robinson et al. 2014 ***Native format:*** 3 arc-second grid ***Units:*** decimeters per km

***Column name*** **sgr_dk_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {r} along reach segment

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** rav




| | |
|---|---|
| ***Data description*** | EarthEnv-DEM90 is a digital elevation model that provides elevation values for a pixel resolution of 3 arc-seconds (approximately 90m at the equator). It is derived from CGIAR-CSI SRTM v4.1 and ASTER GDEM v2 data products. These data have been processed and merged to provide a continuous coverage between 60˚S and 83˚N. Stream gradients were computed after removing single pixel sinks by lifting them to the minimum elevation of their eight surrounding pixels. The 3 arc-second pixels were then aggregated to 15 arc-second resolution using the 'minimum' statistic (to preserve the valley bottom height within the larger pixel). Finally, the stream gradient was calculated as the ratio between the elevation drop within the river reach (i.e. the difference between min. and max. elevation along the reach) and the length of the reach. |
| ***Reference*** | Robinson, N., Regetz, J., Guralnick, R.P. (2014). EarthEnv-DEM90: A nearly-global, void-free, multi-scale smoothed, 90m digital elevation model from fused ASTER and SRTM data. ISPRS Journal of Photogrammetry and Remote Sensing, 87, 57-67. doi: 10.1016/j.isprsjprs.2013.11.002. |
| ***Website*** | http://www.earthenv.org/DEM |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | NoData values (-9999) were assigned to all of Greenland because calculated stream gradients were not within reasonable ranges due to substantial outliers in DEM over the Greenland ice sheet. |

| | | | |
|---|---|---|---|
| ***Category*** | Climate | ID-C01 | ***>>> Back to Attribute List*** |

## *Attribute* Climate Zones

***Source data*** Global Environmental Stratification (GEnS)

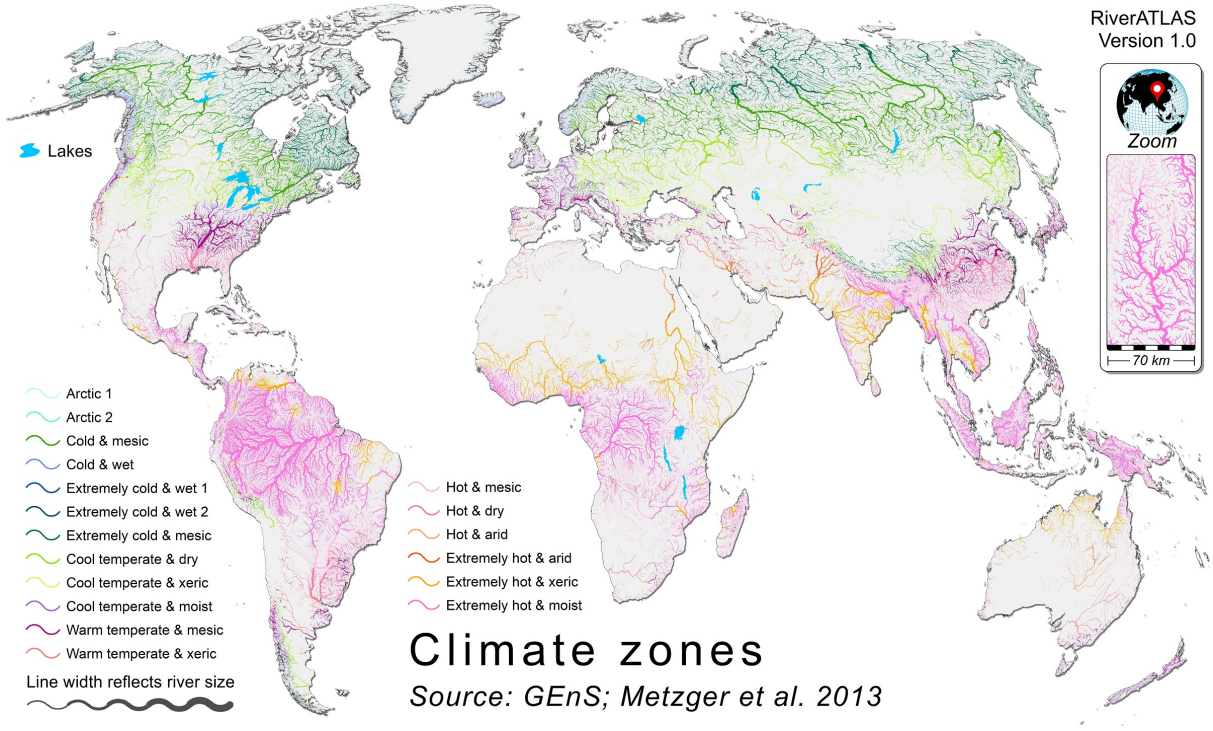
***Citation:*** Metzger et al. 2013 ***Native format:*** Polygons ***Units:*** classes (18)

***Column name*** **clz_cl_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {mj} spatial majority

***Existing suffixes {xoo}:*** cmj




| | |
|---|---|
| ***Data description*** | The Global Environmental Stratification (GEnS) is a statistically derived global bioclimate classification (representative of the year 2000) that provides a global spatial framework for the integration and analysis of ecological and environmental data. The dataset used statistical analysis to distinguish 125 environmental strata based on 42 variables. To facilitate accessibility, these strata were aggregated into 18 environmental zones. |
| ***Reference*** | Metzger, M.J., Bunce, R.G., Jongman, R.H., Sayre, R., Trabucco, A., Zomer, R. (2013). A high-resolution bioclimate map of the world: a unifying framework for global biodiversity research and monitoring. Global Ecology and Biogeography, 22(5), 630-638. |
| ***Website*** | https://edinburgh-innovations.ed.ac.uk/project/bioclimate-world-map |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | For class names see file HydroATLAS_v10_Legends.xlsx. |

| | | | |
|---|---|---|---|
| ***Category*** | Climate | ID-C02 | ***>>> Back to Attribute List*** |

## *Attribute* Climate Strata

***Source data*** Global Environmental Stratification (GEnS)

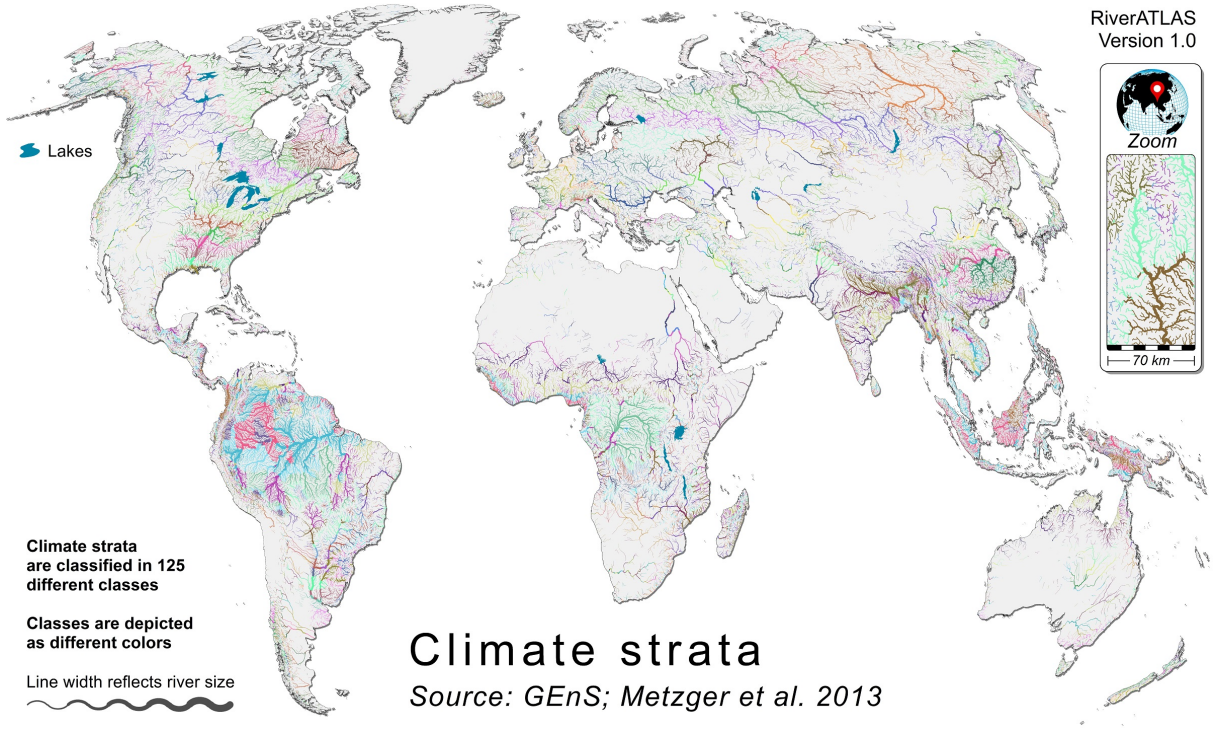
***Citation:*** Metzger et al. 2013 ***Native format:*** Polygons ***Units:*** classes (125)

***Column name*** **cls_cl_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {mj} spatial majority

***Existing suffixes {xoo}:*** cmj




| | |
|---|---|
| ***Data description*** | The Global Environmental Stratification (GEnS) is a statistically derived global bioclimate classification (representative of the year 2000) that provides a global spatial framework for the integration and analysis of ecological and environmental data. The dataset used statistical analysis to distinguish 125 environmental strata based on 42 variables. To facilitate accessibility, these strata were aggregated into 18 environmental zones. |
| ***Reference*** | Metzger, M.J., Bunce, R.G., Jongman, R.H., Sayre, R., Trabucco, A., Zomer, R. (2013). A high-resolution bioclimate map of the world: a unifying framework for global biodiversity research and monitoring. Global Ecology and Biogeography, 22(5), 630-638. |
| ***Website*** | https://edinburgh-innovations.ed.ac.uk/project/bioclimate-world-map |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | For class names see file HydroATLAS_v10_Legends.xlsx. |

| | | | |
|---|---|---|---|
| ***Category*** | Climate | ID-C03 | ***>>> Back to Attribute List*** |

## *Attribute* Air Temperature

***Source data*** WorldClim v1.4

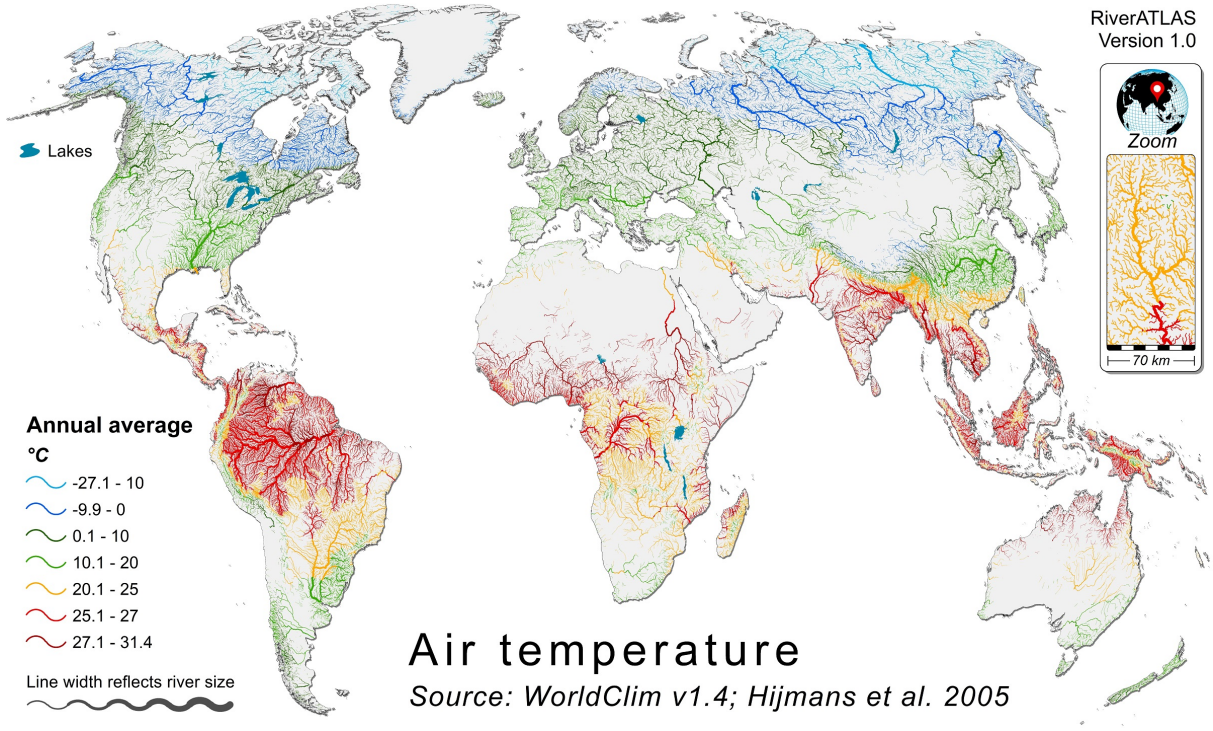
***Citation:*** Hijmans et al. 2005 ***Native format:*** 30 arc-second grid ***Units:*** degrees Celsius (x10)

***Column name*** **tmp_dc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {yr} annual average | {mn} annual minimum | {mx} annual maximum | {01-12} monthly average

***Existing suffixes {xoo}:*** cyr | cmn | cmx | c01-c12 | uyr




| | |
|---|---|
| ***Data description*** | WorldClim is a database of interpolated global climate surfaces (excluding Antarctica) at a spatial resolution of 30 arc-seconds. Input data for the generation of WorldClim were gathered from a variety of sources (~70,000 stations) and, where possible, were restricted to records from 1950 to 2000. WorldClim applied the thin-plate smoothing spline algorithm implemented in the ANUSPLIN package for interpolation, using latitude, longitude, and elevation as independent variables. The climate elements included in HydroATLAS are mean monthly and annual precipitation; and mean, minimum, and maximum monthly and annual temperature. |
| ***Reference*** | Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G., Jarvis, A. (2005). Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology, 25(15), 1965-1978. |
| ***Website*** | http://worldclim.org/ |
| ***License*** | Original: Creative Commons CC-BY-SA 4.0 -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | In the stored data, degree values were multiplied by 10 (i.e. value 10 means 1 degree Celsius). Annual minimum and maximum temperatures were derived from the 12 long-term average monthly temperature values, i.e. they represent the temperature of the lowest or highest month within the average year. |

| | | | |
|---|---|---|---|
| ***Category*** | Climate | ID-C04 | ***>>> Back to Attribute List*** |

## *Attribute* Precipitation

***Source data*** WorldClim v1.4

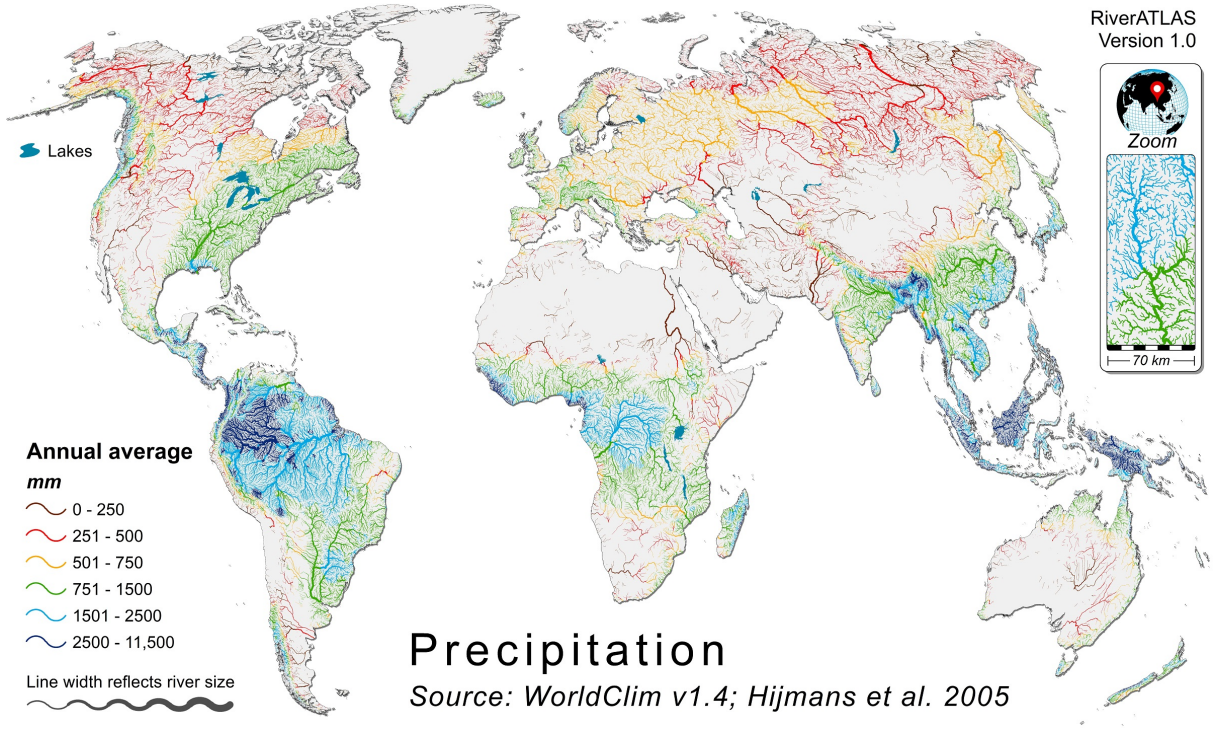
***Citation:*** Hijmans et al. 2005 ***Native format:*** 30 arc-second grid ***Units:*** millimeters

***Column name*** **pre_mm_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {yr} annual average | {01-12} monthly average

***Existing suffixes {xoo}:*** cyr | c01-c12 | uyr




| | |
|---|---|
| ***Data description*** | WorldClim is a database of interpolated global climate surfaces (excluding Antarctica) at a spatial resolution of 30 arc-seconds. Input data for the generation of WorldClim were gathered from a variety of sources (~70,000 stations) and, where possible, were restricted to records from 1950 to 2000. WorldClim applied the thin-plate smoothing spline algorithm implemented in the ANUSPLIN package for interpolation, using latitude, longitude, and elevation as independent variables. The climate elements included in HydroATLAS are mean monthly and annual precipitation; and mean, minimum, and maximum monthly and annual temperature. |
| ***Reference*** | Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G., Jarvis, A. (2005). Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology, 25(15), 1965-1978. |
| ***Website*** | http://worldclim.org/ |
| ***License*** | Original: Creative Commons CC-BY-SA 4.0 -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | None |

| | | | |
|---|---|---|---|
| ***Category*** | Climate | ID-C05 | ***>>> Back to Attribute List*** |

# *Attribute* Potential Evapotranspiration

***Source data*** Global-PET v1

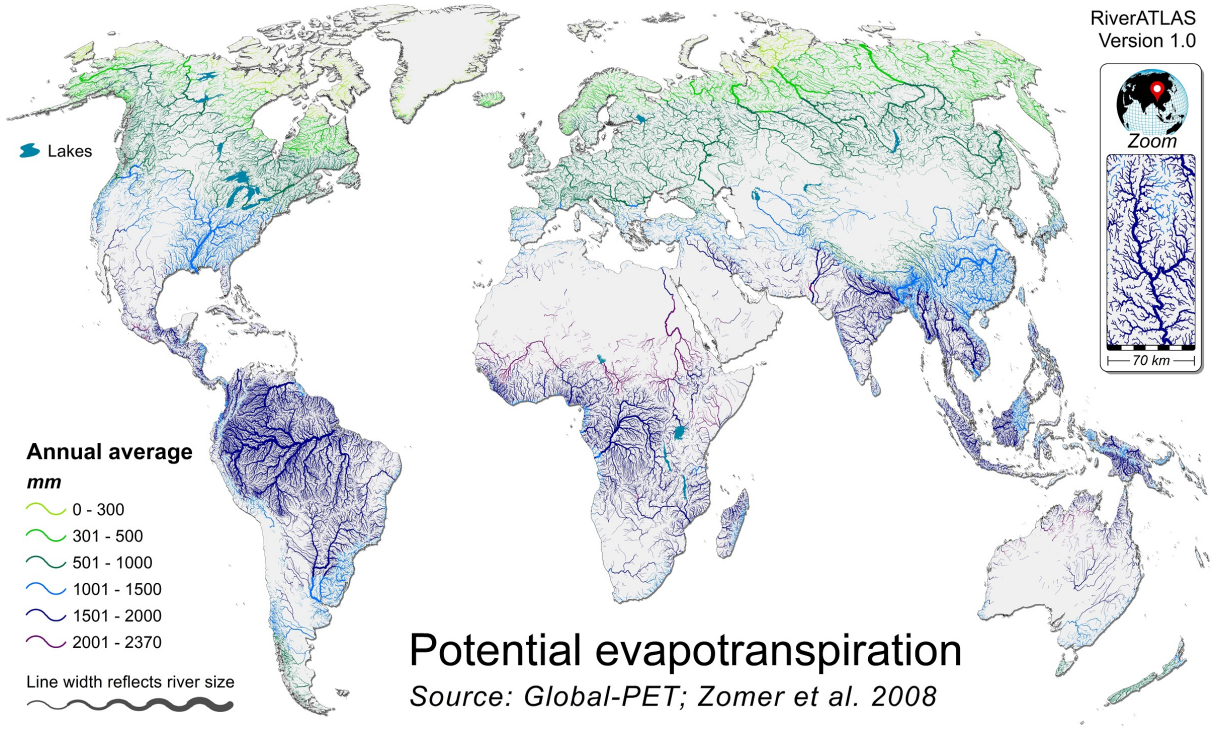
***Citation:*** Zomer et al. 2008 ***Native format:*** 30 arc-second grid ***Units:*** millimeters

***Column name*** **pet_mm_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {yr} annual average | {01-12} monthly average

***Existing suffixes {xoo}:*** cyr | c01-c12 | uyr




| | |
|---|---|
| ***Data description*** | Global Potential Evapotranspiration (Global-PET) is modeled using data from WorldClim as input parameters. WorldClim is insufficient to fully parameterize physical radiation-based PET equations; however, it can be used to parameterize simpler temperature-based PET equations. Based on the results of comparative validations for South America and Africa, the Hargreaves model was chosen as the most suitable to model PET globally. |
| ***Reference*** | Zomer, R.J., Trabucco, A., Bossio, D.A., van Straaten, O., Verchot, L.V. (2008). Climate change mitigation: A spatial analysis of global land suitability for clean development mechanism afforestation and reforestation. Agriculture, Ecosystems & Environment, 126(1), 67-80. |
| ***Website*** | https://cgiarcsi.community/data/global-aridity-and-pet-database |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | Additional required citation: Trabucco, A., Zomer, R.J., Bossio, D.A., van Straaten, O., Verchot, L.V. (2008). Climate change mitigation through afforestation/reforestation: A global analysis of hydrologic impacts with four case studies. Agriculture, Ecosystems and Environment, 126, 81-97. |

| | | | |
|---|---|---|---|
| ***Category*** | Climate | ID-C06 | ***>>> Back to Attribute List*** |

# *Attribute* Actual Evapotranspiration

***Source data*** Global High-Resolution Soil-Water Balance

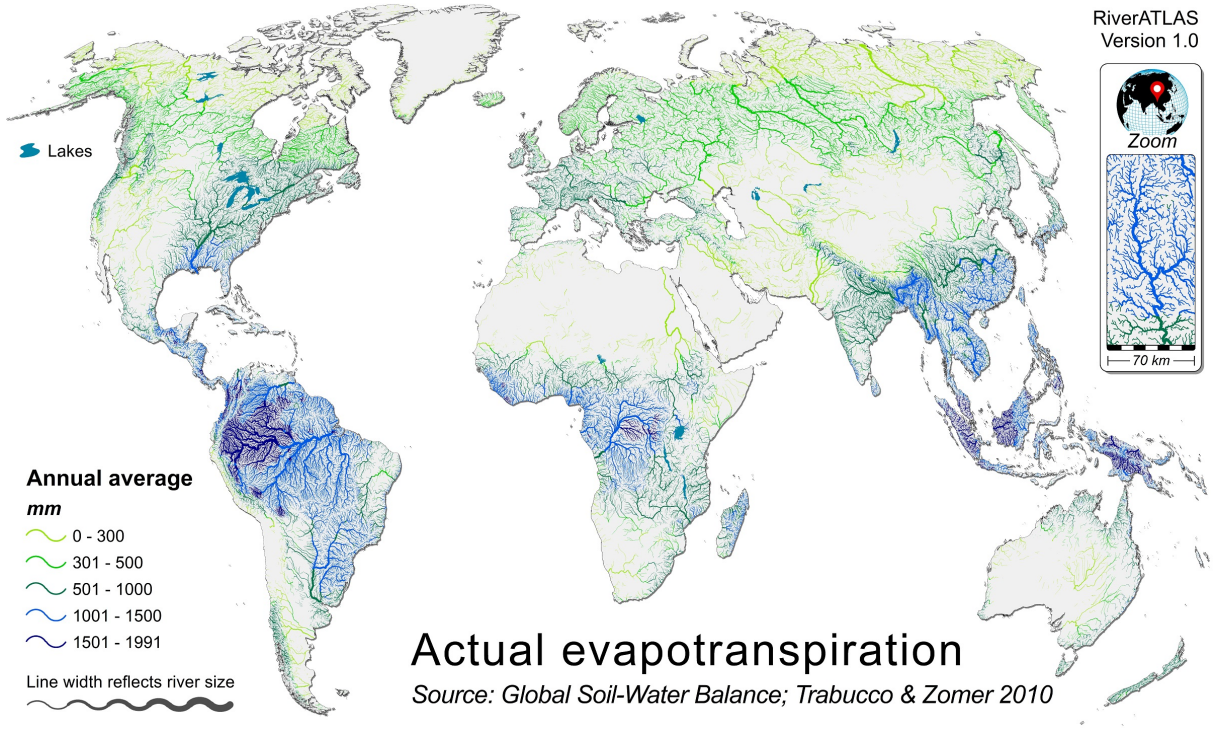
***Citation:*** Trabucco & Zomer 2010 ***Native format:*** 30 arc-second grid ***Units:*** millimeters

***Column name*** **aet_mm_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {yr} annual average | {01-12} monthly average

***Existing suffixes {xoo}:*** cyr | c01-c12 | uyr




| | |
|---|---|
| ***Data description*** | Global Actual Evapotranspiration (Global-AET) is provided as part of the Global High-Resolution Soil-Water Balance dataset which contains gridded estimates of actual evapotranspiration and soil water deficit. The dataset defines the monthly fraction of soil water content available for evapotranspiration processes (as a percentage of the maximum soil water content). It is therefore a measure of soil stress, and equal to the soil water stress coefficient as a percentage. This dataset utilizes the WorldClim and Global-PET databases as primary input. The results highlight specifically the climatic influence on hydrological dimensions that regulate vegetation suitability. |
| ***Reference*** | Trabucco, A., Zomer, R.J. (2010). Global soil water balance geospatial database. CGIAR Consortium for Spatial Information. Available from the CGIAR-CSI GeoPortal at https://cgiarcsi.community. |
| ***Website*** | https://cgiarcsi.community/data/global-high-resolution-soil-water-balance |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | None |

| | | | |
|---|---|---|---|
| ***Category*** | Climate | ID-C07 | ***>>> Back to Attribute List*** |

# *Attribute* Global Aridity Index

***Source data*** Global Aridity Index v1

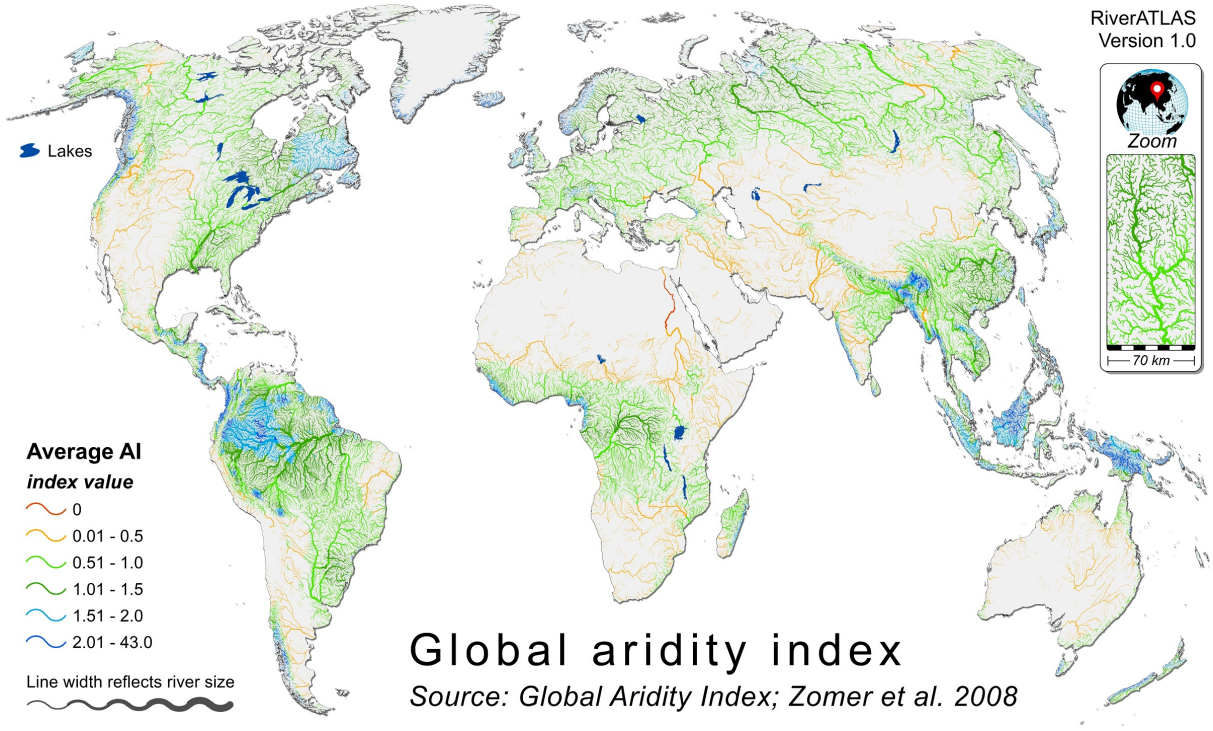
***Citation:*** Zomer et al. 2008 ***Native format:*** 30 arc-second grid ***Units:*** index value (x100)

***Column name*** **ari_ix_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** cav | uav




| | |
|---|---|
| ***Data description*** | The Global Aridity Index (Global-Aridity) is modeled using data from WorldClim as input parameters. Aridity is usually expressed as a generalized function of precipitation, temperature, and/or potential evapotranspiration (PET). For this global aridity index, it was calculated as mean annual precipitation over mean annual PET, i.e. rainfall over vegetation water demand (aggregated on an annual basis). Under this formulation, the aridity index values increase with more humid conditions, and decrease with more arid conditions. An aridity index value of 0 represents areas of no preciptiation, a value of 1 represent areas where precipitation equals PET, and a value >1 represents areas where precipitation exceeds PET. Note that maximum values were capped at 100. |
| ***Reference*** | Zomer, R.J., Trabucco, A., Bossio, D.A., van Straaten, O., Verchot, L.V. (2008). Climate change mitigation: A spatial analysis of global land suitability for clean development mechanism afforestation and reforestation. Agriculture, Ecosystems & Environment, 126(1), 67-80. |
| ***Website*** | https://cgiarcsi.community/data/global-aridity-and-pet-database |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | In the stored data, index values are multiplied by 100 (i.e. value 100 means 1). Additional required citation: Trabucco, A., Zomer, R.J., Bossio, D.A., van Straaten, O., Verchot, L.V. (2008). Climate change mitigation through afforestation/reforestation: A global analysis of hydrologic impacts with four case studies. Agriculture, Ecosystems and Environment, 126, 81-97. |

| | | | |
|---|---|---|---|
| ***Category*** | Climate | ID-C08 | ***>>> Back to Attribute List*** |

## *Attribute* Climate Moisture Index

***Source data*** WorldClim v1.4 and Global-PET v1

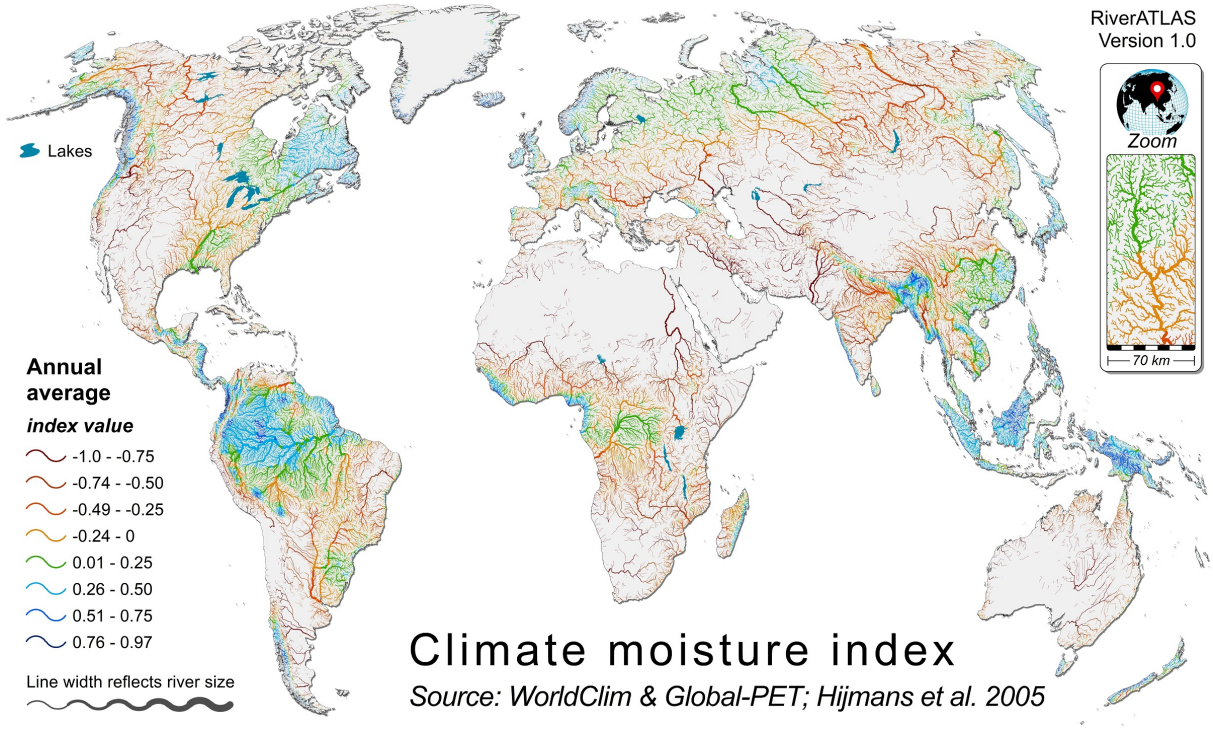
***Citation:*** Hijmans et al. 2005 ***Native format:*** 30 arc-second grids ***Units:*** index value (x100)

***Column name*** **cmi_ix_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {yr} annual average | {01-12} monthly average

***Existing suffixes {xoo}:*** cyr | c01-c12 | uyr




| | |
|---|---|
| ***Data description*** | The Climate Moisture Index (CMI) was derived from the annual precipitation (P) and potential evapotranspiration (PET) datasets as provided by the WorldClim v1.4 (Hijmans et al. 2005) and Global-PET v1 (Zomer et al. 2008) databases, respectively. The CMI was calculated using the equations presented in Willmott and Feddema (1992, see Website link below): [CMI = (P / PET) - 1 when P < PET] or [CMI = 1 - (PET / P) when P >= PET]. The resulting values range from -1 to 1. |
| ***Reference*** | Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G., Jarvis, A. (2005). Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology, 25(15), 1965-1978. |
| ***Website*** | http://climate.geog.udel.edu/~climate/publication_html/Pdf/WF_ProfGeog_92.pdf |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | In the stored data, index values are multiplied by 100 (i.e. value 100 means 1). Additional required citation: Zomer, R.J., Trabucco, A., Bossio, D.A., van Straaten, O., Verchot, L.V. (2008). Climate change mitigation: A spatial analysis of global land suitability for clean development mechanism afforestation and reforestation. Agriculture, Ecosystems & Environment, 126(1), 67-80. |

| | | | |
|---|---|---|---|
| ***Category*** | Climate | ID-C09 | ***>>> Back to Attribute List*** |

# *Attribute* Snow Cover Extent

***Source data*** MODIS/Aqua Snow Cover (MYD10CM)

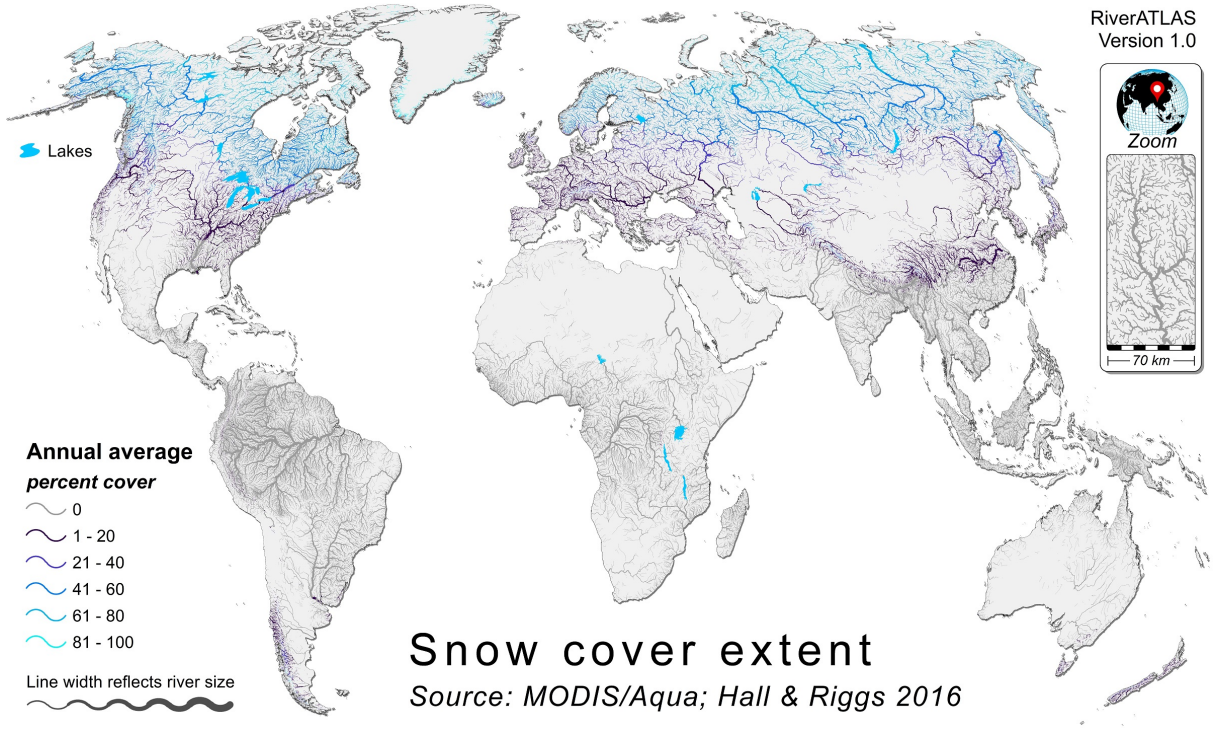
***Citation:*** Hall & Riggs 2016 ***Native format:*** 15 arc-second grid ***Units:*** percent cover

***Column name*** **snw_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {yr} annual average | {mx} annual maximum | {01-12} monthly average

***Existing suffixes {xoo}:*** cyr | cmx | c01-c12 | uyr




| | |
|---|---|
| ***Data description*** | The MODIS/Aqua Snow Cover Daily L3 Global 500m Grid (MYD10A1) contains data on snow cover and fractional snow cover. MYD10A1 consists of 1200 km by 1200 km tiles gridded in a sinusoidal map projection. Moderate Resolution Imaging Spectroradiometer (MODIS) snow cover data are based on a snow mapping algorithm that employs a Normalized Difference Snow Index (NDSI) and other criteria tests. In HydroATLAS, snow cover extent is derived from the daily global sunlit images for the period between July 2002 and April 2015. |
| ***Reference*** | Hall, D.K., Riggs, G.A. (2016). MODIS/Aqua Snow Cover Daily L3 Global 500m SIN Grid, Version 6. [2002-2015]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. |
| ***Website*** | https://doi.org/10.5067/MODIS/MYD10A1.006 |
| ***License*** | Original: Public Domain -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | None |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L01 | ***>>> Back to Attribute List*** |

# *Attribute* Land Cover Classes

***Source data*** GLC2000

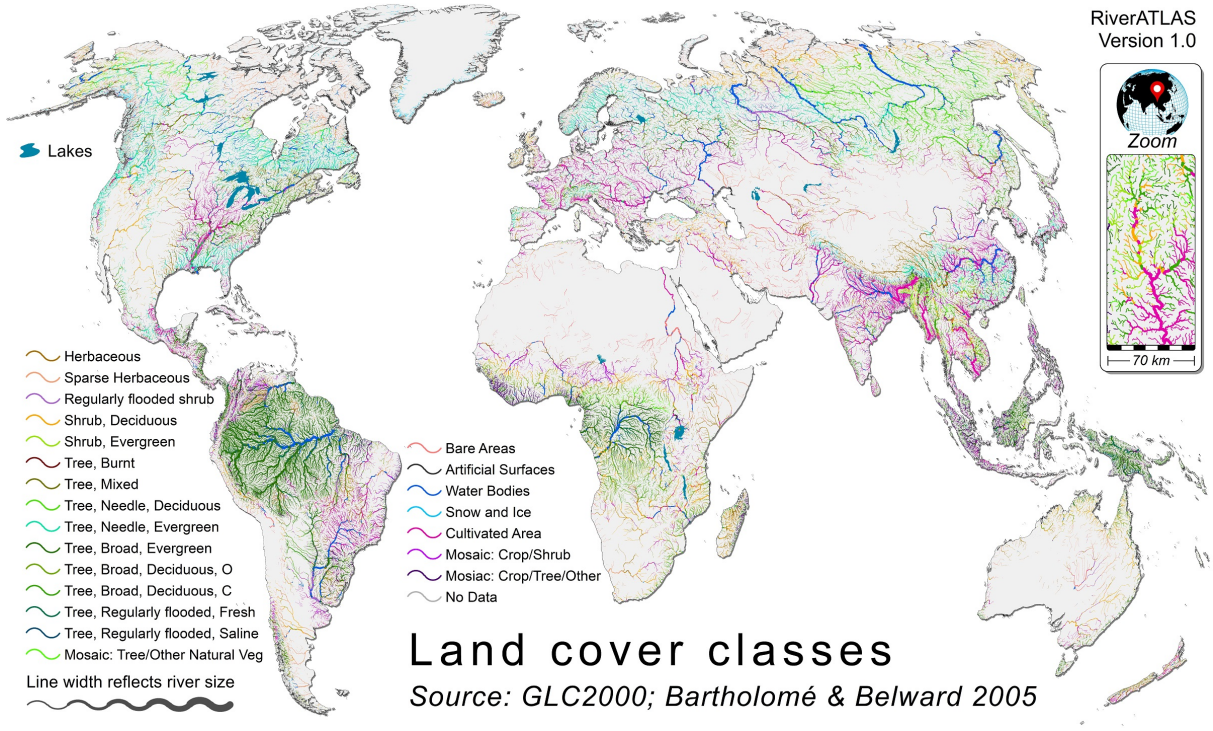
***Citation:*** Bartholomé & Belward 2005 ***Native format:*** 30 arc-second grid ***Units:*** classes (22)

***Column name*** **glc_cl_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {mj} spatial majority

***Existing suffixes {xoo}:*** cmj




| | |
|---|---|
| ***Data description*** | The GLC2000 (Global Land Cover in the year 2000) database distinguishes 22 land cover classes and was produced by an international partnership of 30 research groups coordinated by the European Commission's Joint Research Centre. Land cover maps were based on daily data from the SPOT vegetation sensor (VEGA 2000 dataset: a dataset of 14 months of pre-processed daily global data acquired by the VEGETATION instrument on board the SPOT 4 satellite) and other Earth observing sensors. The general objective was to provide a harmonized land cover database over the whole globe for the year 2000. The year 2000 is considered as a reference year for environmental assessment in relation to various activities, in particular the United Nation's Ecosystem-related International Conventions. |
| ***Reference*** | Bartholomé, E., Belward, A.S. (2005). GLC2000: a new approach to global land cover mapping from Earth observation data. International Journal of Remote Sensing, 26(9), 1959-1977. |
| ***Website*** | https://forobs.jrc.ec.europa.eu/products/glc2000/glc2000.php |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | For class names see file HydroATLAS_v10_Legends.xlsx. |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L02 | ***>>> Back to Attribute List*** |

# *Attribute* Land Cover Extent

***Source data*** GLC2000

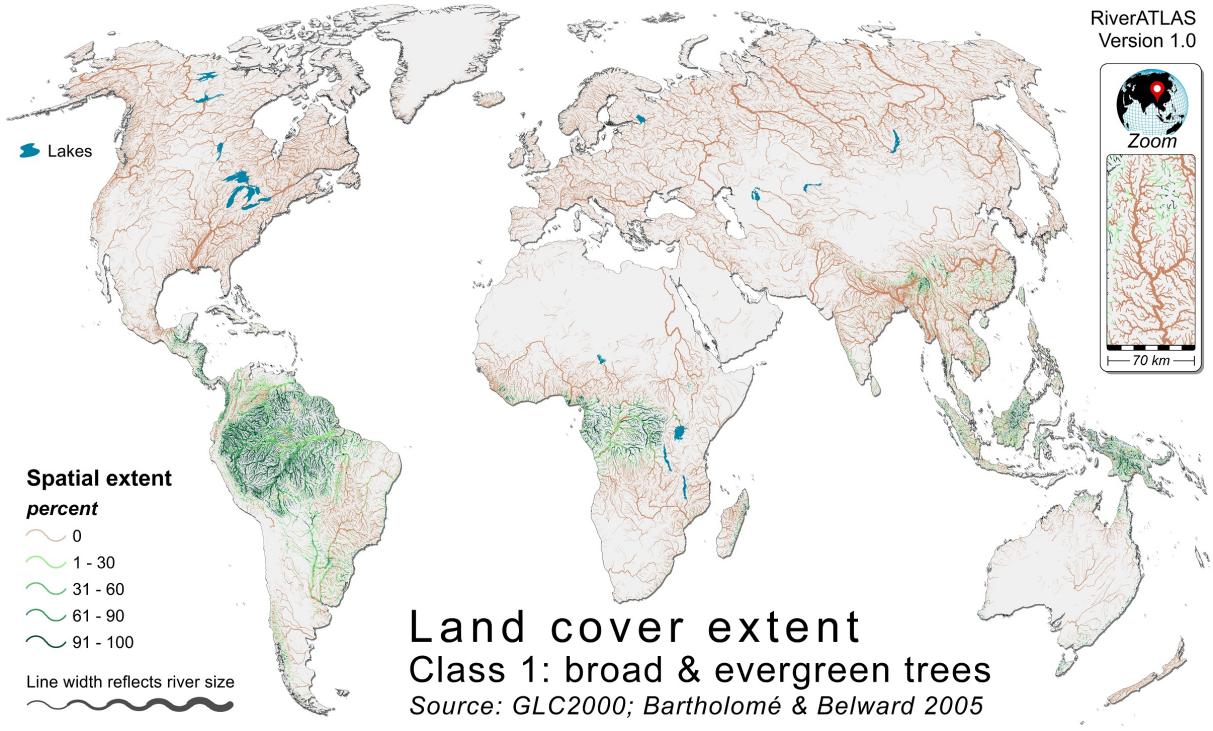
***Citation:*** Bartholomé & Belward 2005 ***Native format:*** 30 arc-second grid ***Units:*** percent cover

***Column name*** **glc_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {01-22} spatial extent (%) by class

***Existing suffixes {xoo}:*** c01-c22 | u01-u22




| | |
|---|---|
| ***Data description*** | The GLC2000 (Global Land Cover in the year 2000) database distinguishes 22 land cover classes and was produced by an international partnership of 30 research groups coordinated by the European Commission's Joint Research Centre. Land cover maps were based on daily data from the SPOT vegetation sensor (VEGA 2000 dataset: a dataset of 14 months of pre-processed daily global data acquired by the VEGETATION instrument on board the SPOT 4 satellite) and other Earth observing sensors. The general objective was to provide a harmonized land cover database over the whole globe for the year 2000. The year 2000 is considered as a reference year for environmental assessment in relation to various activities, in particular the United Nation's Ecosystem-related International Conventions. |
| ***Reference*** | Bartholomé, E., Belward, A.S. (2005). GLC2000: a new approach to global land cover mapping from Earth observation data. International Journal of Remote Sensing, 26(9), 1959-1977. |
| ***Website*** | https://forobs.jrc.ec.europa.eu/products/glc2000/glc2000.php |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | For class names see file HydroATLAS_v10_Legends.xlsx. All forest classes combined (1-8) are also available as an additional attribute of Forest Cover Extent (see L07). |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L03 | ***>>> Back to Attribute List*** |

# ***Attribute*** Potential Natural Vegetation Classes

***Source data*** EarthStat

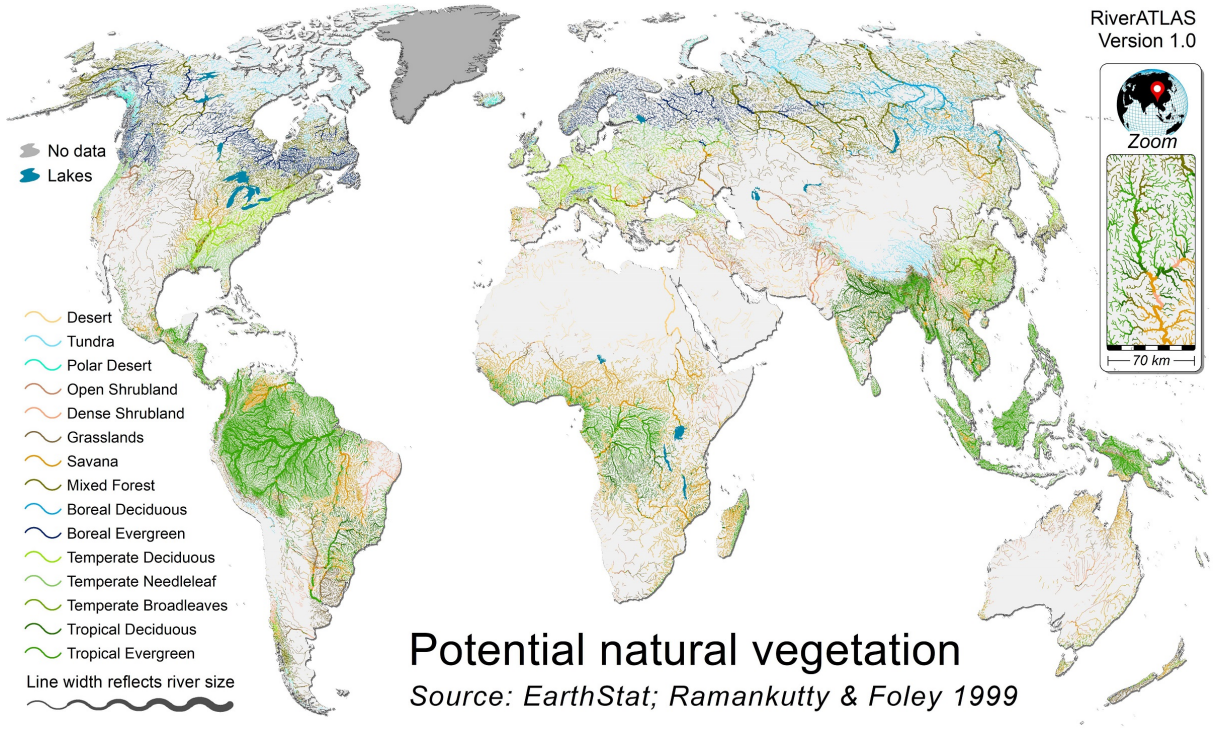
***Citation:*** Ramankutty & Foley 1999 ***Native format:*** 5 arc-min grid ***Units:*** classes (15)

***Column name*** **pnv_cl_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {mj} spatial majority

***Existing suffixes {xoo}:*** cmj




| | |
|---|---|
| ***Data description*** | The EarthStat database includes a global map of natural vegetation classified into 15 vegetation types. It is representative of the world's vegetation that would most likely exist now in the absence of human activities. In regions not dominated by human land use, vegetation types are those currently observed from a satellite. This data set is derived mainly from the DISCover land cover data set, with the regions dominated by antrhopogenic land use filled using the vegetation data set of Haxeltine and Prentice (1996). |
| ***Reference*** | Ramankutty, N., Foley, J.A. (1999). Estimating historical changes in global land cover: Croplands from 1700 to 1992. Global Biogeochemical Cycles, 13(4), 997-1027. |
| ***Website*** | https://nelson.wisc.edu/sage/data-and-models/global-potential-vegetation/index.php |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | For class names see file HydroATLAS_v10_Legends.xlsx. Further reading: Haxeltine, A., Prentice, C.I. (1996). BIOME3: An equilibrium terrestrial biosphere model based on ecophysiological constraints, resource availability, and competition among plant functional types, Global Biogeochemical Cycles, 10(4), 693-709. |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L04 | ***>>> Back to Attribute List*** |

# *Attribute* Potential Natural Vegetation Extent

***Source data*** EarthStat

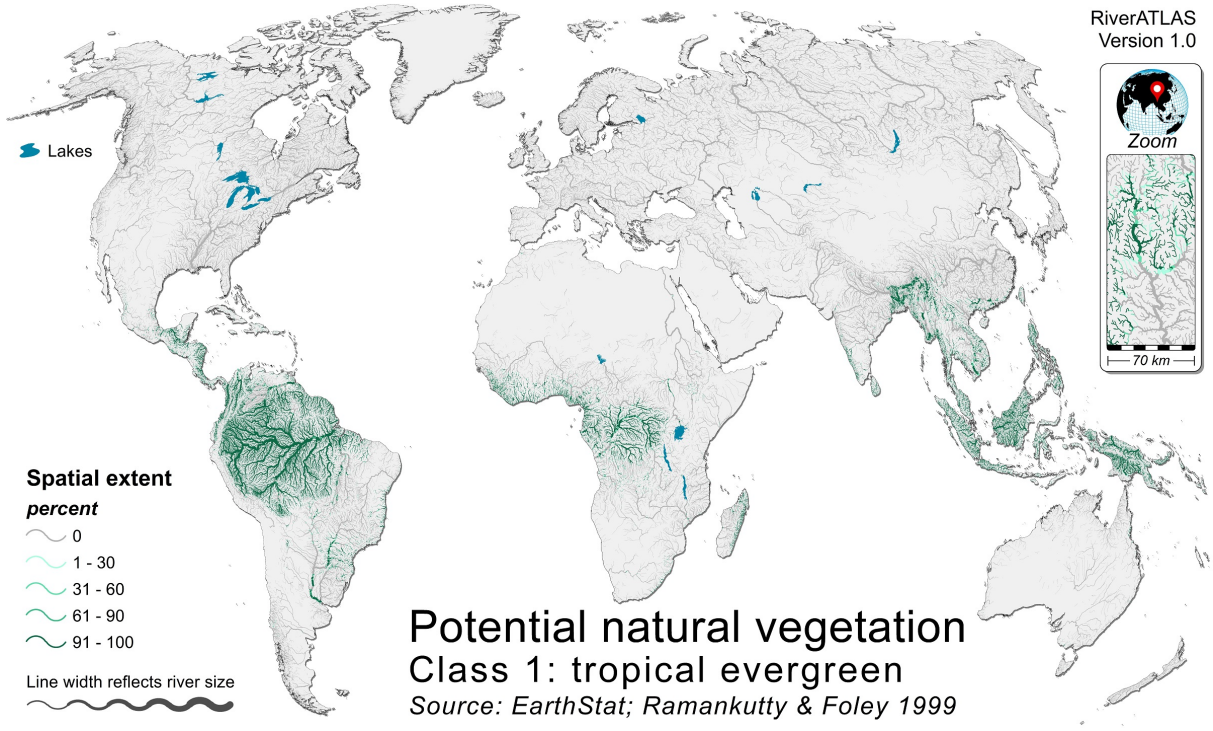
***Citation:*** Ramankutty & Foley 1999 ***Native format:*** 5 arc-min grid ***Units:*** percent cover

***Column name*** **pnv_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {01-15} spatial extent (%) by class

***Existing suffixes {xoo}:*** c01-c15 | u01-u15




***Data description***

The EarthStat database includes a global map of natural vegetation classified into 15 vegetation types. It is representative of the world's vegetation that would most likely exist now in the absence of human activities. In regions not dominated by human land use, vegetation types are those currently observed from a satellite. This data set is derived mainly from the DISCover land cover data set, with the regions dominated by antrhopogenic land use filled using the vegetation data set of Haxeltine and Prentice (1996).

***Reference***

Ramankutty, N., Foley, J.A. (1999). Estimating historical changes in global land cover: Croplands from 1700 to 1992. Global Biogeochemical Cycles, 13(4), 997-1027.

***Website*** https://nelson.wisc.edu/sage/data-and-models/global-potential-vegetation/index.php

***License*** Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0

***Additional information***

For class names see file HydroATLAS_v10_Legends.xlsx. Further reading: Haxeltine, A., Prentice, C.I. (1996). BIOME3: An equilibrium terrestrial biosphere model based on ecophysiological constraints, resource availability, and competition among plant functional types, Global Biogeochemical Cycles, 10(4), 693-709.

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L05 | ***>>> Back to Attribute List*** |

# *Attribute* Wetland Classes

***Source data*** Global Lakes and Wetlands Database (GLWD)

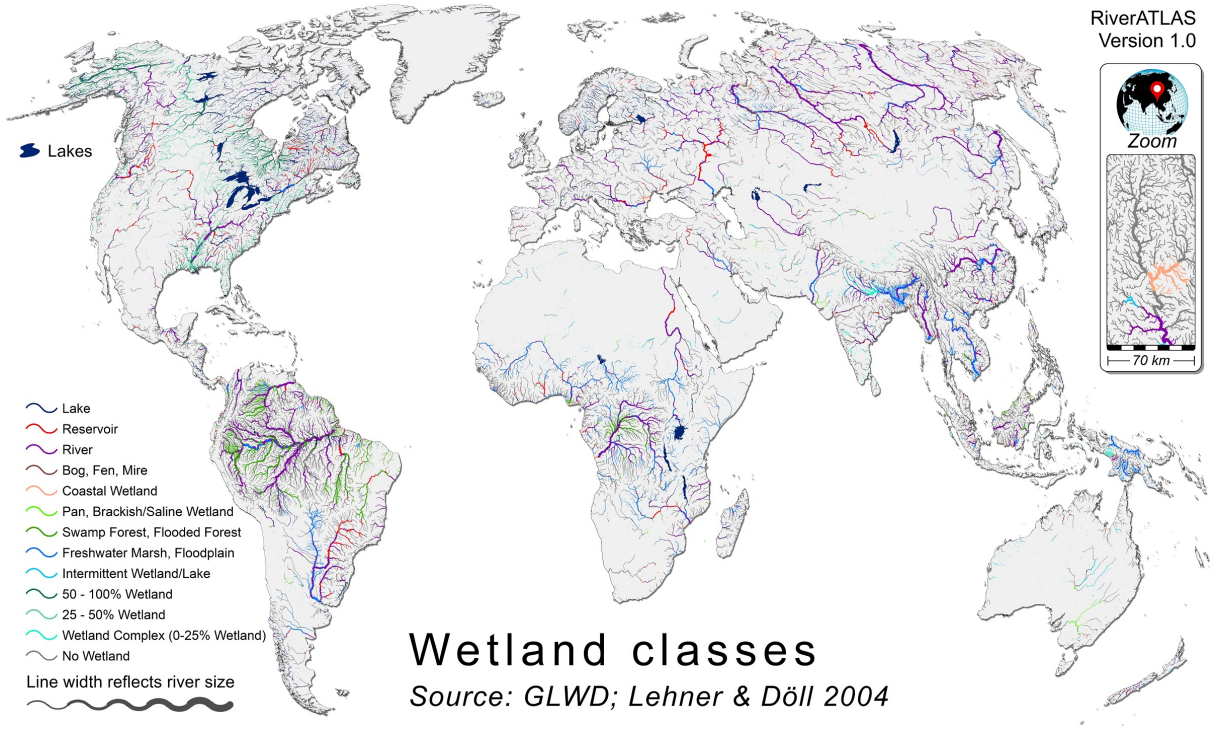
***Citation:*** Lehner & Döll 2004 ***Native format:*** Polygons ***Units:*** classes (12)

***Column name*** **wet_cl_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {mj} spatial majority

***Existing suffixes {xoo}:*** cmj




| | |
|---|---|
| ***Data description*** | The Global Lakes and Wetlands Database (GLWD) was created by WWF and the Center for Environmental Systems Research, University of Kassel, Germany, drawing upon a variety of existing maps, data and information. The combination of best available sources for lakes and wetlands on a global scale (1:1 to 1:3 million resolution), and the application of GIS functionality enabled the generation of a database which focuses in three coordinated levels on (1) large lakes and reservoirs, (2) smaller water bodies, and (3) wetlands. The data used in HydroATLAS is from the gridded 30 arc-second layer of GLWD which distinguishes 12 wetland classes (including lakes, reservoirs, and rivers). |
| ***Reference*** | Lehner, B., Döll, P. (2004). Development and validation of a global database of lakes, reservoirs and wetlands. Journal of Hydrology, 296(1), 1-22. |
| ***Website*** | https://www.worldwildlife.org/pages/global-lakes-and-wetlands-database |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | For class names see file HydroATLAS_v10_Legends.xlsx. For the majority statistics, non-wetland areas were not considered. Value -9999 indicates spatial units that contain no wetland areas. |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L06 | ***>>> Back to Attribute List*** |

## *Attribute* Wetland Extent

***Source data*** Global Lakes and Wetlands Database (GLWD)

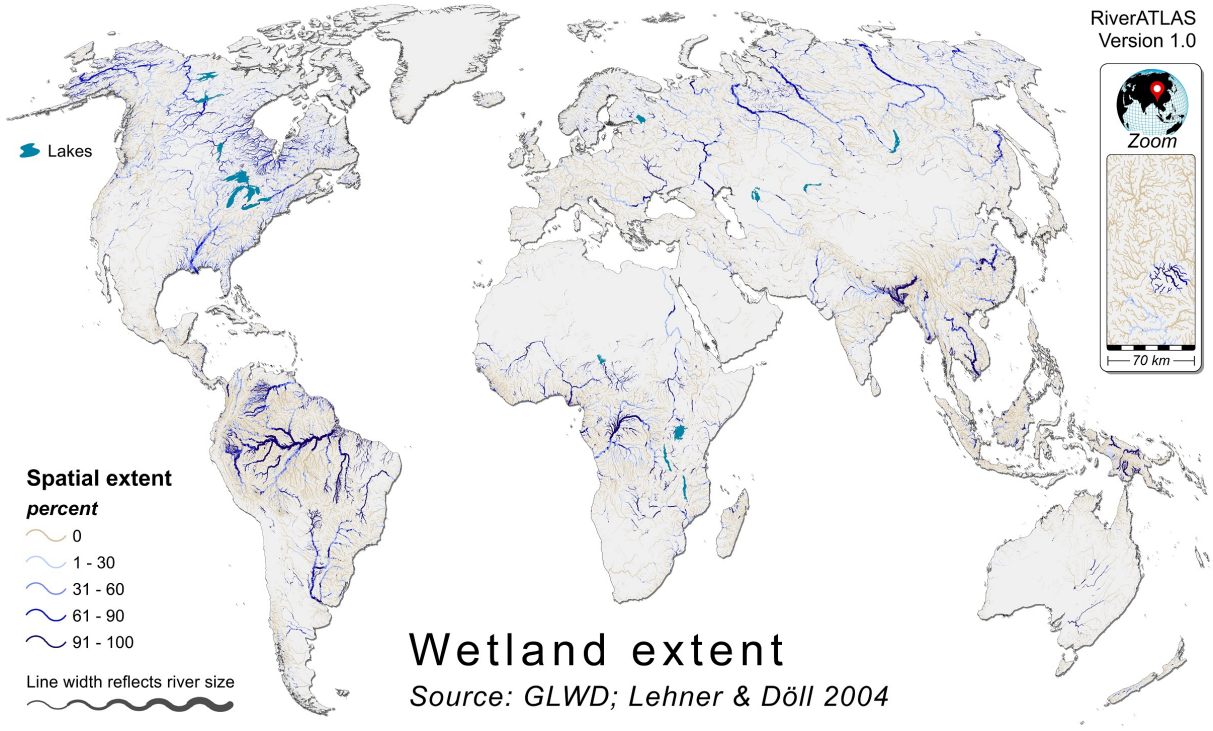
***Citation:*** Lehner & Döll 2004 ***Native format:*** Polygons ***Units:*** percent cover

***Column name*** **wet_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {01-09} spatial extent (%) by class | {g1-g2} spatial extent (%) by class grouping

***Existing suffixes {xoo}:*** c01-c09 | cg1 | cg2 | u01-u09 | ug1 | ug2




| | |
|---|---|
| ***Data description*** | The Global Lakes and Wetlands Database (GLWD) was created by WWF and the Center for Environmental Systems Research, University of Kassel, Germany, drawing upon a variety of existing maps, data and information. The combination of best available sources for lakes and wetlands on a global scale (1:1 to 1:3 million resolution), and the application of GIS functionality enabled the generation of a database which focuses in three coordinated levels on (1) large lakes and reservoirs, (2) smaller water bodies, and (3) wetlands. The data used in HydroATLAS is from the gridded 30 arc-second layer of GLWD which distinguishes 12 wetland classes (including lakes, reservoirs, and rivers). |
| ***Reference*** | Lehner, B., Döll, P. (2004). Development and validation of a global database of lakes, reservoirs and wetlands. Journal of Hydrology, 296(1), 1-22. |
| ***Website*** | https://www.worldwildlife.org/pages/global-lakes-and-wetlands-database |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | For class names see file HydroATLAS_v10_Legends.xlsx. Class grouping 1 (g1) represents all wetland classes (1-12) including lakes, reservoirs and rivers. Class grouping 2 (g2) represents all wetland classes (4-12) excluding lakes, reservoirs and rivers. |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L07 | ***>>> Back to Attribute List*** |

## *Attribute* Forest Cover Extent

***Source data*** GLC2000

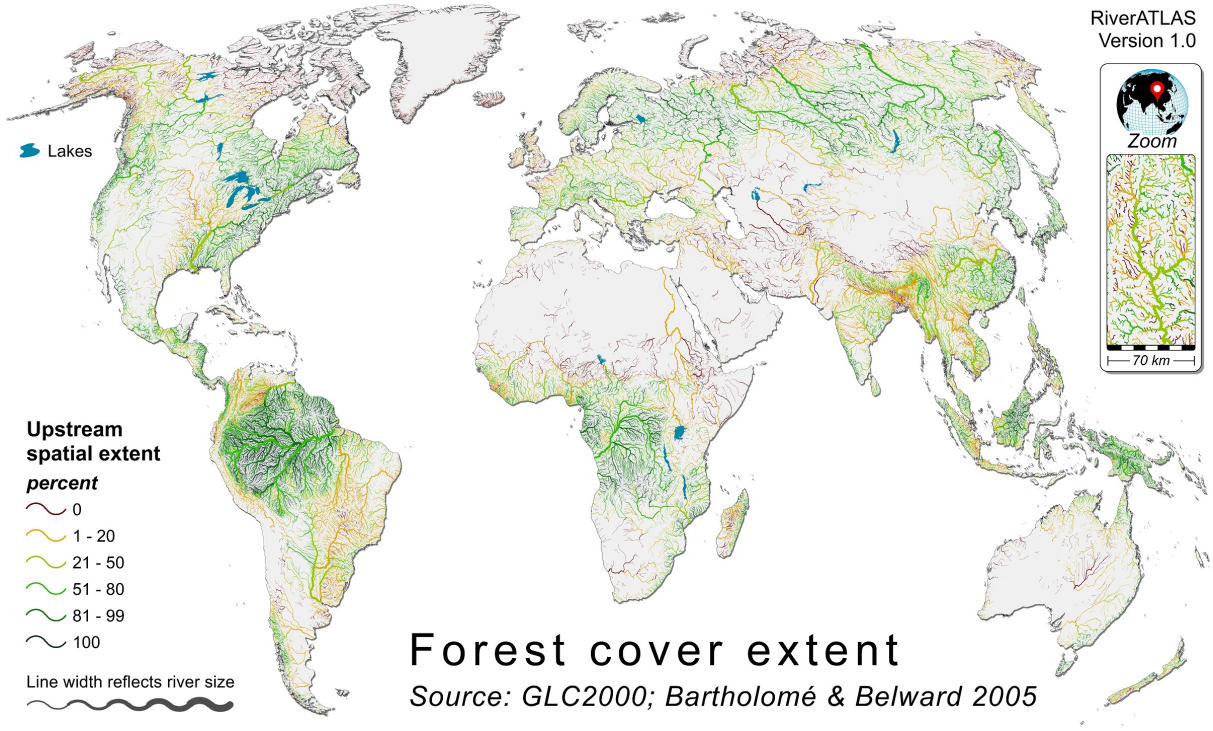
***Citation:*** Bartholomé & Belward 2005 ***Native format:*** 30 arc-second grid ***Units:*** percent cover

***Column name*** **for_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {se} spatial extent (%)

***Existing suffixes {xoo}:*** cse | use




| | |
|---|---|
| ***Data description*** | Forest cover was taken from the GLC2000 land cover map (see L01) by combining classes 1 to 8. GLC2000 was produced by an international partnership of 30 research groups coordinated by the European Commission's Joint Research Centre. Land cover maps were based on daily data from the SPOT vegetation sensor (VEGA 2000 dataset: a dataset of 14 months of pre-processed daily global data acquired by the VEGETATION instrument on board the SPOT 4 satellite) and other Earth observing sensors. The general objective was to provide a harmonized land cover database over the whole globe for the year 2000. The year 2000 is considered as a reference year for environmental assessment in relation to various activities, in particular the United Nation's Ecosystem-related International Conventions. |
| ***Reference*** | Bartholomé, E., Belward, A.S. (2005). GLC2000: a new approach to global land cover mapping from Earth observation data. International Journal of Remote Sensing, 26(9), 1959-1977. |
| ***Website*** | https://forobs.jrc.ec.europa.eu/products/glc2000/glc2000.php |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | None |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L08 | ***>>> Back to Attribute List*** |

## *Attribute* Cropland Extent

***Source data*** EarthStat

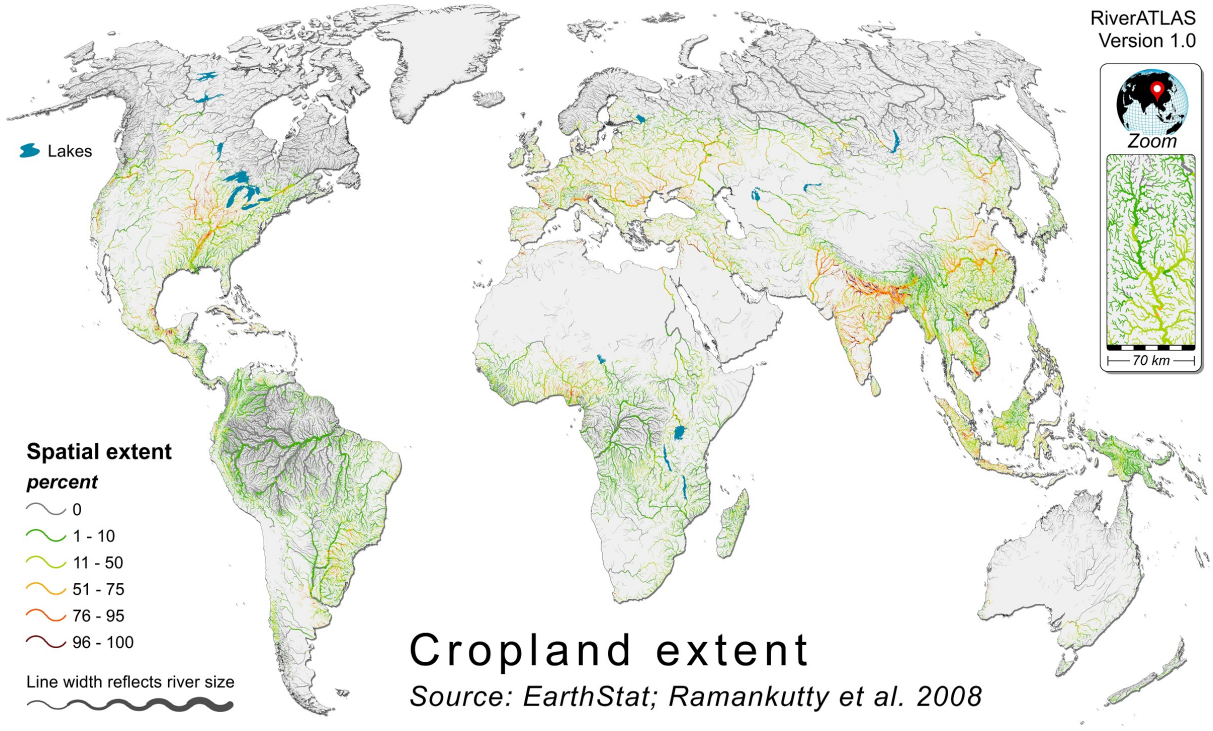
***Citation:*** Ramankutty et al. 2008 ***Native format:*** 5 arc-min grid ***Units:*** percent cover

***Column name*** **crp_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {se} spatial extent (%)

***Existing suffixes {xoo}:*** cse | use




| | |
|---|---|
| ***Data description*** | EarthStat provides a global data set of croplands and pastures circa 2000 by combining agricultural inventory data and satellite-derived land cover data. The agricultural inventory data was used to train a land cover classification dataset obtained by merging two different satellite-derived products (Boston University's MODIS-derived land cover product and the GLC2000 data set). According to EarthStat data, there were 15 million km2 of cropland (12% of the Earth's ice-free land surface) and 28 million km2 of pasture (22%) in the year 2000. |
| ***Reference*** | Ramankutty, N., Evan, A.T., Monfreda, C., Foley, J.A. (2008). Farming the planet: 1. Geographic distribution of global agricultural lands in the year 2000. Global Biogeochemical Cycles, 22(1), 1-19. |
| ***Website*** | http://www.earthstat.org/cropland-pasture-area-2000/ |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | None |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L09 | ***>>> Back to Attribute List*** |

## *Attribute* Pasture Extent

***Source data*** EarthStat

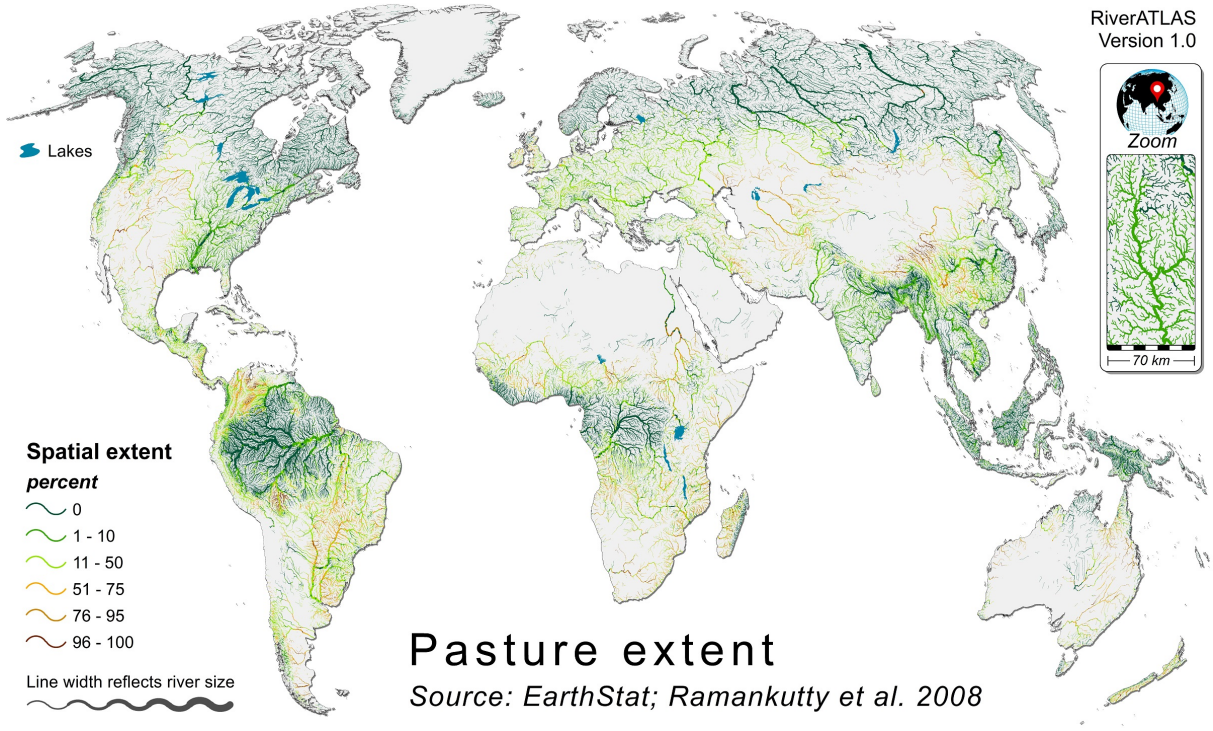
***Citation:*** Ramankutty et al. 2008 ***Native format:*** 5 arc-min grid ***Units:*** percent cover

***Column name*** **pst_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {se} spatial extent (%)

***Existing suffixes {xoo}:*** cse | use




| | |
|---|---|
| ***Data description*** | EarthStat provides a global data set of croplands and pastures circa 2000 by combining agricultural inventory data and satellite-derived land cover data. The agricultural inventory data was used to train a land cover classification dataset obtained by merging two different satellite-derived products (Boston University's MODIS-derived land cover product and the GLC2000 data set). According to EarthStat data, there were 15 million km2 of cropland (12% of the Earth's ice-free land surface) and 28 million km2 of pasture (22%) in the year 2000. |
| ***Reference*** | Ramankutty, N., Evan, A.T., Monfreda, C., Foley, J.A. (2008). Farming the planet: 1. Geographic distribution of global agricultural lands in the year 2000. Global Biogeochemical Cycles, 22(1), 1-19. |
| ***Website*** | http://www.earthstat.org/cropland-pasture-area-2000/ |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | None |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L10 | ***>>> Back to Attribute List*** |

# *Attribute* Irrigated Area Extent (Equipped)

***Source data*** Historical Irrigation Dataset (HID) v1.0

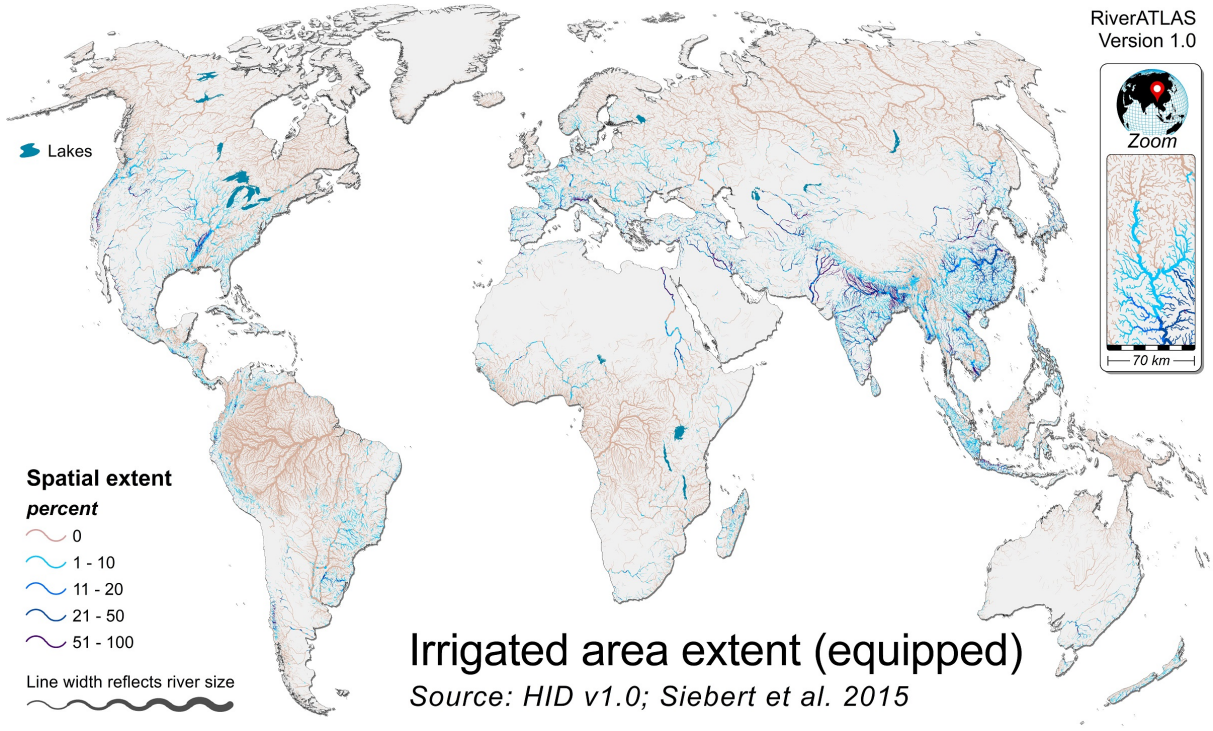
***Citation:*** Siebert et al. 2015 ***Native format:*** 5 arc-min grid ***Units:*** percent cover

***Column name*** **ire_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {se} spatial extent (%)

***Existing suffixes {xoo}:*** cse | use




| | |
|---|---|
| ***Data description*** | The HID (Historical Irrigation Dataset) depicts the extent of area equipped for irrigation (AEI) for 1900 to 2005 in 5 arc-minute resolution. The authors collected subnational irrigation statistics for this period from various sources and found that the global extent of AEI increased from 63 million ha (Mha) in 1900 to 111 Mha in 1950 and 306 Mha in 2005. They developed eight gridded versions of time series of AEI by combining subnational irrigation statistics with different data sets on the historical extent of cropland and pasture. Different rules were applied to maximize consistency of the gridded products to subnational irrigation statistics or to historical cropland and pasture data sets. HydroATLAS includes results for the year 2005. |
| ***Reference*** | Siebert, S., Kummu, M., Porkka, M., Döll, P., Ramankutty, N., Scanlon, B.R. (2015). A global data set of the extent of irrigated land from 1900 to 2005. Hydrology and Earth System Science, 19, 1521-1545. doi:10.5194/hess-19-1521-2015 |
| ***Website*** | https://doi.org/10.13019/M20599 |
| ***License*** | Original: Creative Commons CC-0 -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | HydroATLAS uses the AEI_EARTHSTAT_IR_2005 version of available HID grids which maximizes consistency with subnational irrigation statistics (based on discussions in Siebert et al. 2015). |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L11 | ***>>> Back to Attribute List*** |

# *Attribute* Glacier Extent

***Source data*** Global Land Ice Measurements from Space (GLIMS)

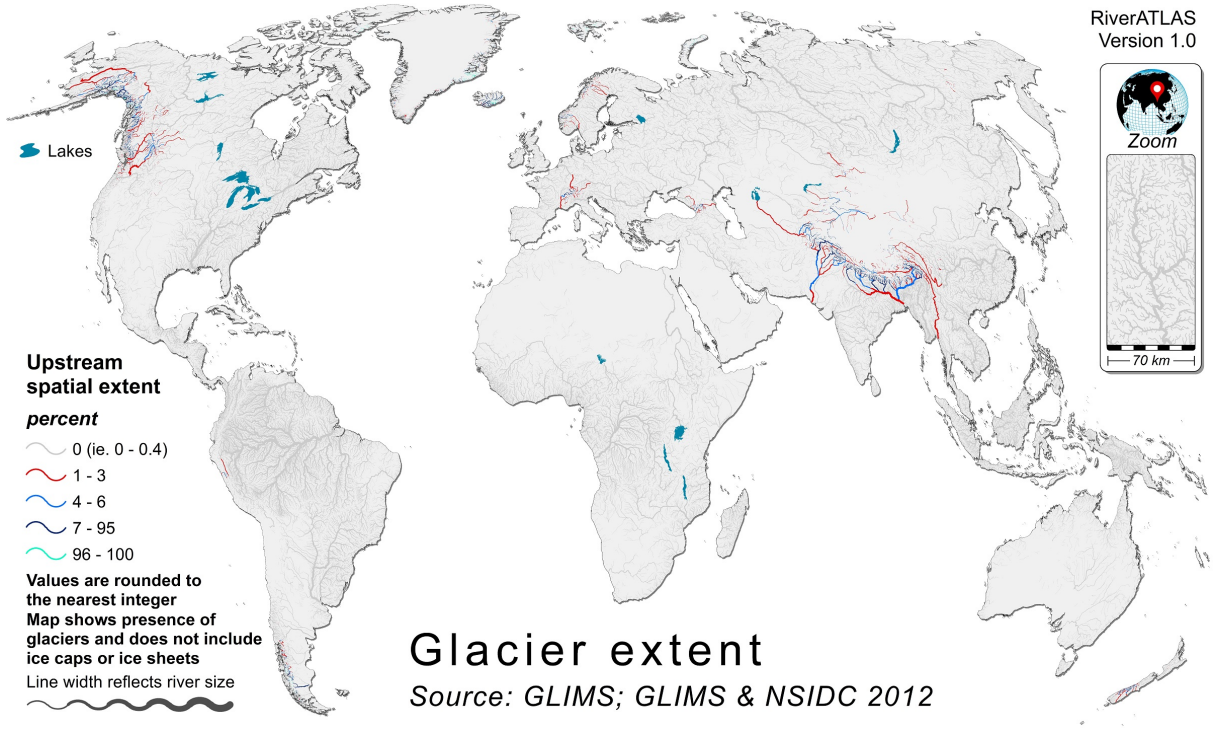
***Citation:*** GLIMS & NSIDC 2012 ***Native format:*** Polygons ***Units:*** percent cover

***Column name*** **gla_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {se} spatial extent (%)

***Existing suffixes {xoo}:*** cse | use




| | |
|---|---|
| ***Data description*** | Global Land Ice Measurements from Space (GLIMS) is an international initiative with the goal of repeatedly surveying the world's estimated 200,000 glaciers, from 1950 to 2015. GLIMS uses data collected by the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) instrument aboard the Terra satellite and the LANDSAT series of satellites, along with historical observations. The GLIMS initiative has created a unique glacier inventory, storing information about the extent and rates of change of all the world's mountain glaciers and ice caps. |
| ***Reference*** | GLIMS and National Snow and Ice Data Center (2005, updated 2012). GLIMS Glacier Database, V1. Boulder, Colorado USA: National Snow and Ice Data Center. NSIDC: National Snow and Ice Data Center. doi:http://dx.doi.org/10.7265/N5V98602 |
| ***Website*** | http://glims.colorado.edu/glacierdata/ |
| ***License*** | Original: Public Domain -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | None |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L12 | ***>>> Back to Attribute List*** |

# *Attribute* Permafrost Extent

***Source data*** Permafrost Zonation Index (PZI)

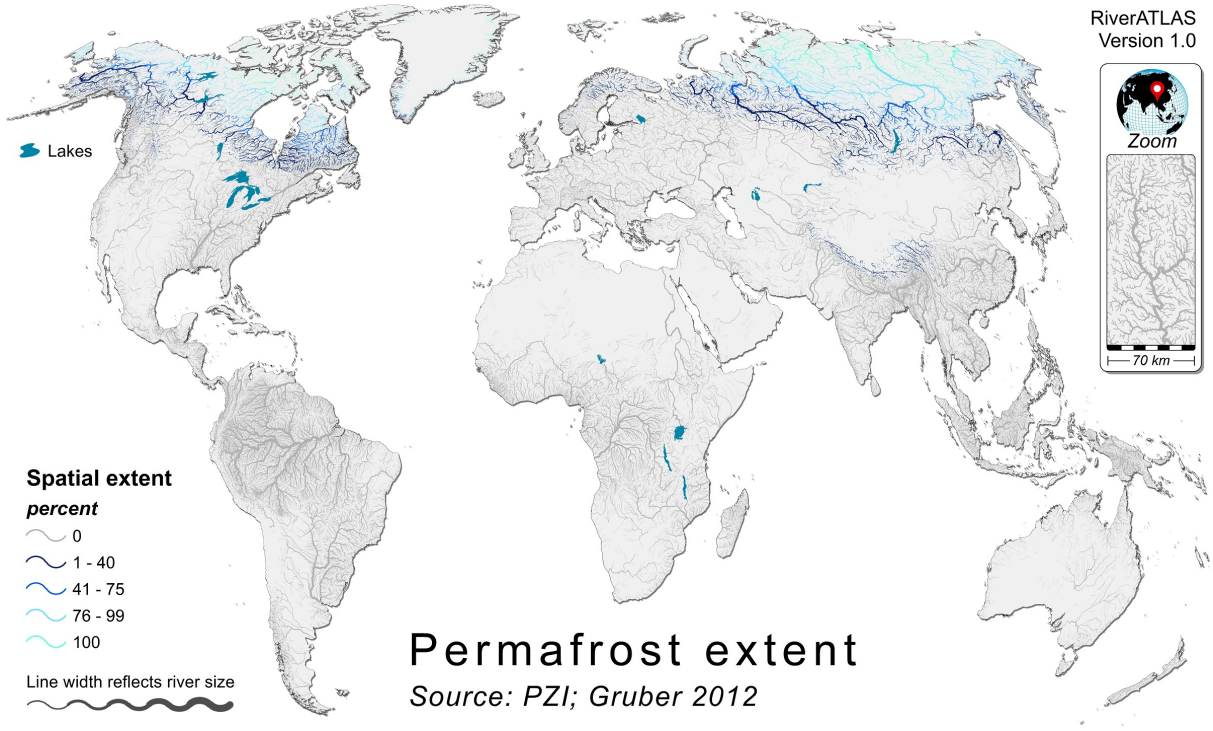
***Citation:*** Gruber 2012 ***Native format:*** 30 arc-second grid ***Units:*** percent cover

***Column name*** **prm_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {se} spatial extent (%)

***Existing suffixes {xoo}:*** cse | use




| | |
|---|---|
| ***Data description*** | The global Permafrost Zonation Index (PZI) map indicates to what degree permafrost exists only in (1) the most favorable conditions or (2) nearly everywhere. Established relationships between air temperature and the occurrence of permafrost were re-formulated into a model that was parameterized using published estimates (for period 1961-90). The global permafrost area including Antarctic and sub-sea permafrost is estimated to be 16-21 million square kilometers. The global permafrost region, i.e. the exposed land surface below which some permafrost can be expected, is estimated to be 22 ± 3 million square kilometers. |
| ***Reference*** | Gruber, S. (2012). Derivation and analysis of a high-resolution estimate of global permafrost zonation. The Cryosphere, 6(1), 221. |
| ***Website*** | http://www.geo.uzh.ch/microsite/cryodata/pf_global/ |
| ***License*** | Original: Freely available -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | None |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L13 | ***>>> Back to Attribute List*** |

## *Attribute* Protected Area Extent

***Source data*** World Database on Protected Areas (WDPA)

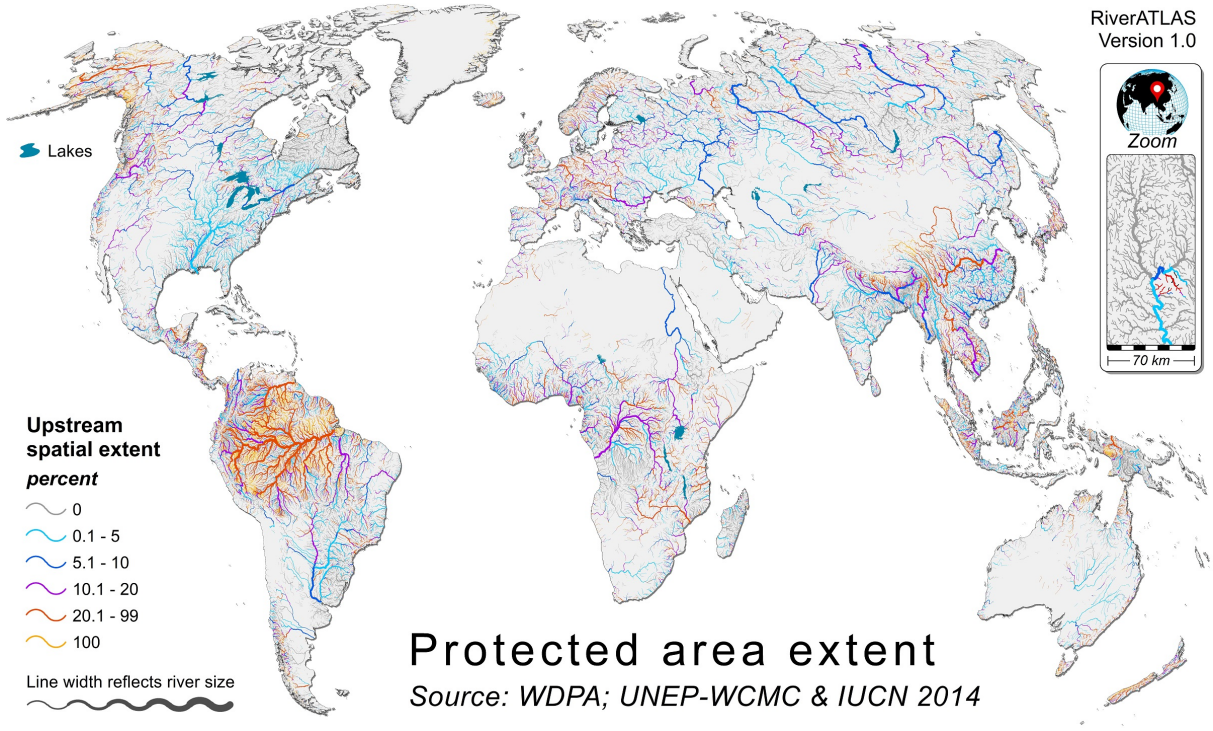
***Citation:*** IUCN & UNEP-WCMC 2014 ***Native format:*** Polygons & points ***Units:*** percent cover

***Column name*** **pac_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {se} spatial extent (%)

***Existing suffixes {xoo}:*** cse | use




| | |
|---|---|
| ***Data description*** | The World Database on Protected Areas (WDPA) is the most comprehensive global database of marine and terrestrial protected areas. It is a joint effort between IUCN and UNEP, managed by UNEP-WCMC, to compile protected area information for all countries in the world from governments and other authoritative organizations. HydroATLAS includes all nationally designated PAs (DESIG TYPE = “national”; STATUS = “designated”) of all IUCN categories (IUCN CAT = “I-VI,” “not reported,” or “not assigned”) from the October 2014 version of WDPA (160,000 polygons representing 19.2 million km2). In cases where PA sites were only given as point data (17,000 points representing 1.1 million km2), their spatial extent was approximated as a circle with a size representing the reported area. |
| ***Reference*** | UNEP-WCMC and IUCN (UN Environment World Conservation Monitoring Centre and International Union for Conservation of Nature) (2014). The World Database on Protected Areas (WDPA). UNEP-WCMC and IUCN, Cambridge, UK. Available at: www.protectedplanet.net. |
| ***Website*** | https://www.protectedplanet.net/ |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | The World Database on Protected Areas (WDPA) is updated on a regular basis and the latest version is available at https://www.protectedplanet.net/. |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L14 | ***>>> Back to Attribute List*** |

# *Attribute* Terrestrial Biomes

***Source data*** Terrestrial Ecoregions of the World (TEOW)

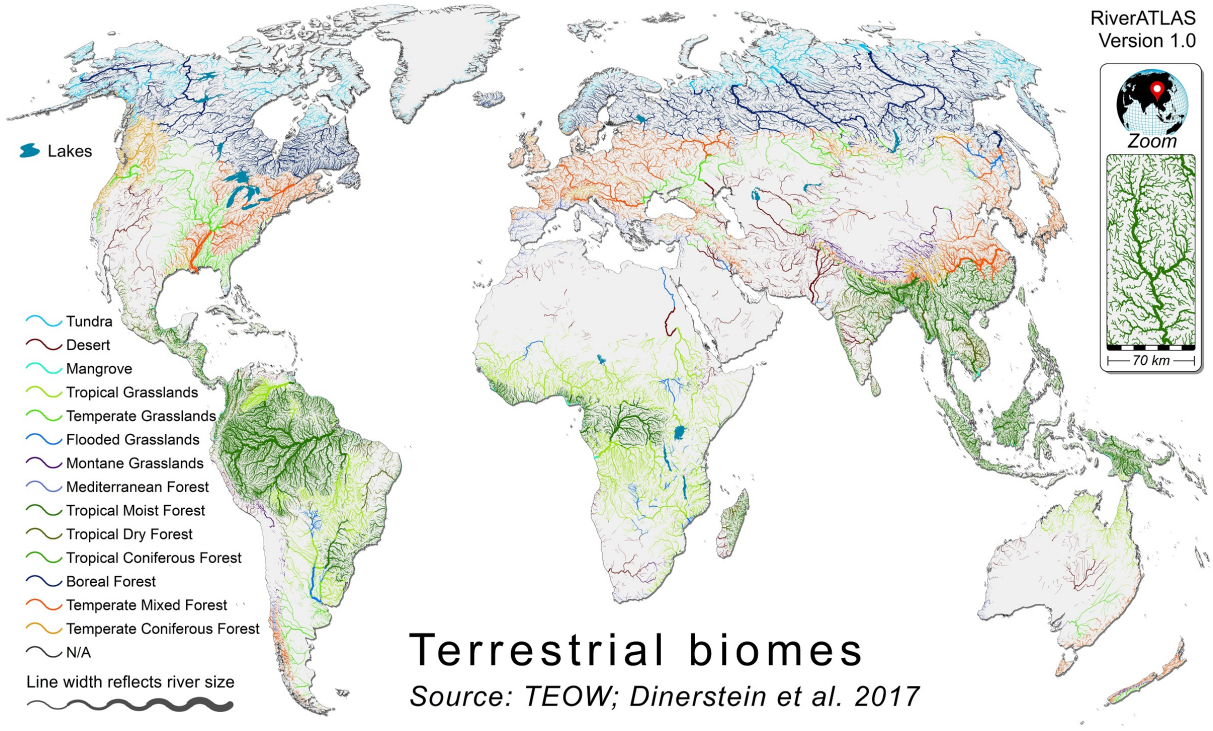
***Citation:*** Dinerstein et al. 2017 ***Native format:*** Polygons ***Units:*** classes (14)

***Column name*** **tbi_cl_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {mj} spatial majority

***Existing suffixes {xoo}:*** cmj




***Data description***

Terrestrial Ecoregions of the World (TEOW) is a biogeographic regionalization that defines ecoregions and biomes as relatively large units of land or water containing a distinct assemblage of natural communities sharing a large majority of species, dynamics, and environmental conditions of the Earth's terrestrial biodiversity. Globally, there are 846 distinct terrestrial ecoregions, classified into 14 different biomes such as forests, grasslands, or deserts. Note that this version included in HydroATLAS is an updated version from the original TEOW database (Olson et al. 2001).

***Reference***

Dinerstein, E., Olson, D., Joshi, A., Vynne, C., Burgess, N. D., Wikramanayake, E., ... & Hansen, M. (2017). An ecoregion-based approach to protecting half the terrestrial realm. BioScience, 67(6), 534-545. doi:10.1093/biosci/bix014

***Website*** https://ecoregions2017.appspot.com/

***License*** Creative Commons CC-BY 4.0

***Additional information***

For legend see file HydroATLAS_v10_Legends.xlsx. This is an updated version of the original TEOW map: Olson, D.M., Dinerstein, E., Wikramanayake, E.D., Burgess, N.D., Powell, G.V.N., Underwood, E.C., ... & Kassem, K.R. (2001). Terrestrial ecoregions of the world: a new map of life on Earth. BioScience, 51(11), 933-938. Note that 'noData' areas on original map, including some large lakes, were allocated to the nearest biome or ecoregion.

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L15 | ***>>> Back to Attribute List*** |

# *Attribute* Terrestrial Ecoregions

***Source data*** Terrestrial Ecoregions of the World (TEOW)

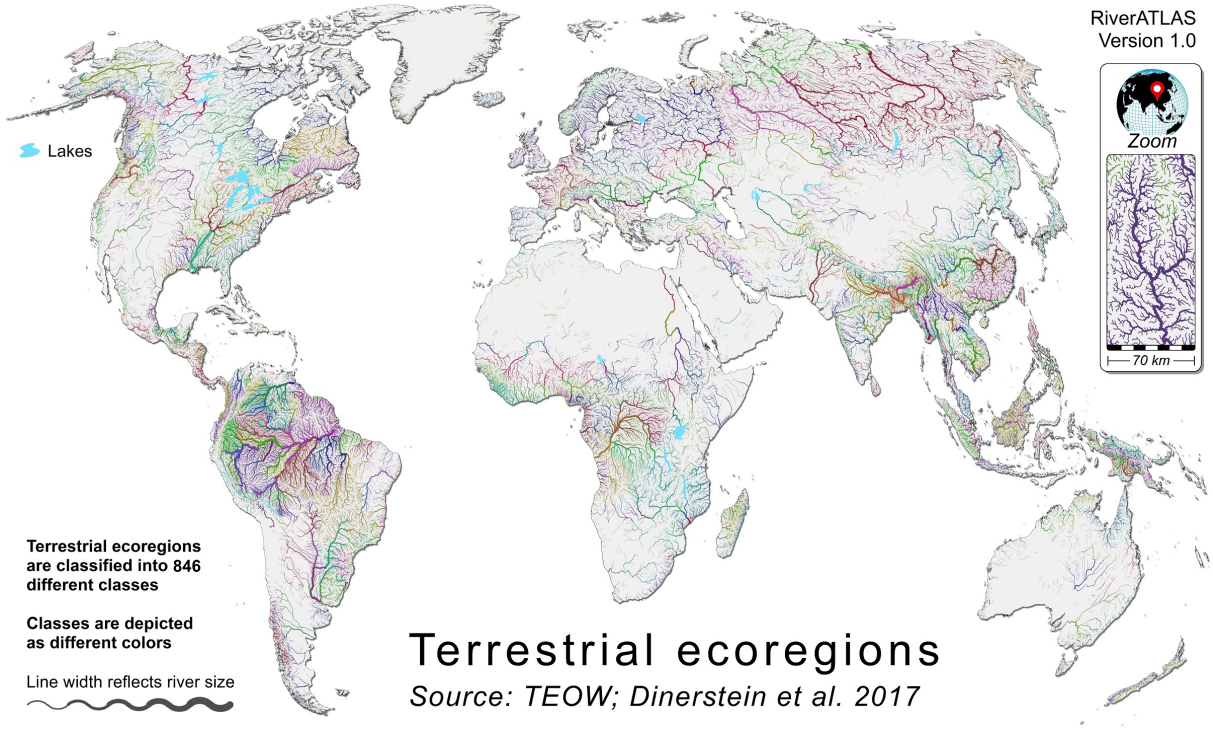
***Citation:*** Dinerstein et al. 2017 ***Native format:*** Polygons ***Units:*** classes (846)

***Column name*** **tec_cl_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {mj} spatial majority

***Existing suffixes {xoo}:*** cmj




***Data description***

Terrestrial Ecoregions of the World (TEOW) is a biogeographic regionalization that defines ecoregions and biomes as relatively large units of land or water containing a distinct assemblage of natural communities sharing a large majority of species, dynamics, and environmental conditions of the Earth's terrestrial biodiversity. Globally, there are 846 distinct terrestrial ecoregions, classified into 14 different biomes such as forests, grasslands, or deserts. Note that this version included in HydroATLAS is an updated version from the original TEOW database (Olson et al. 2001).

***Reference***

Dinerstein, E., Olson, D., Joshi, A., Vynne, C., Burgess, N. D., Wikramanayake, E., ... & Hansen, M. (2017). An ecoregion-based approach to protecting half the terrestrial realm. BioScience, 67(6), 534-545. doi:10.1093/biosci/bix014

***Website*** https://ecoregions2017.appspot.com/

***License*** Creative Commons CC-BY 4.0

***Additional information***

For legend see file HydroATLAS_v10_Legends.xlsx. This is an updated version of the original TEOW map: Olson, D.M., Dinerstein, E., Wikramanayake, E.D., Burgess, N.D., Powell, G.V.N., Underwood, E.C., ... & Kassem, K.R. (2001). Terrestrial ecoregions of the world: a new map of life on Earth. BioScience, 51(11), 933-938. Note that 'noData' areas on original map, including some large lakes, were allocated to the nearest biome or ecoregion.

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L16 | ***>>> Back to Attribute List*** |

# *Attribute* Freshwater Major Habitat Types

***Source data*** Freshwater Ecoregions of the World (FEOW)

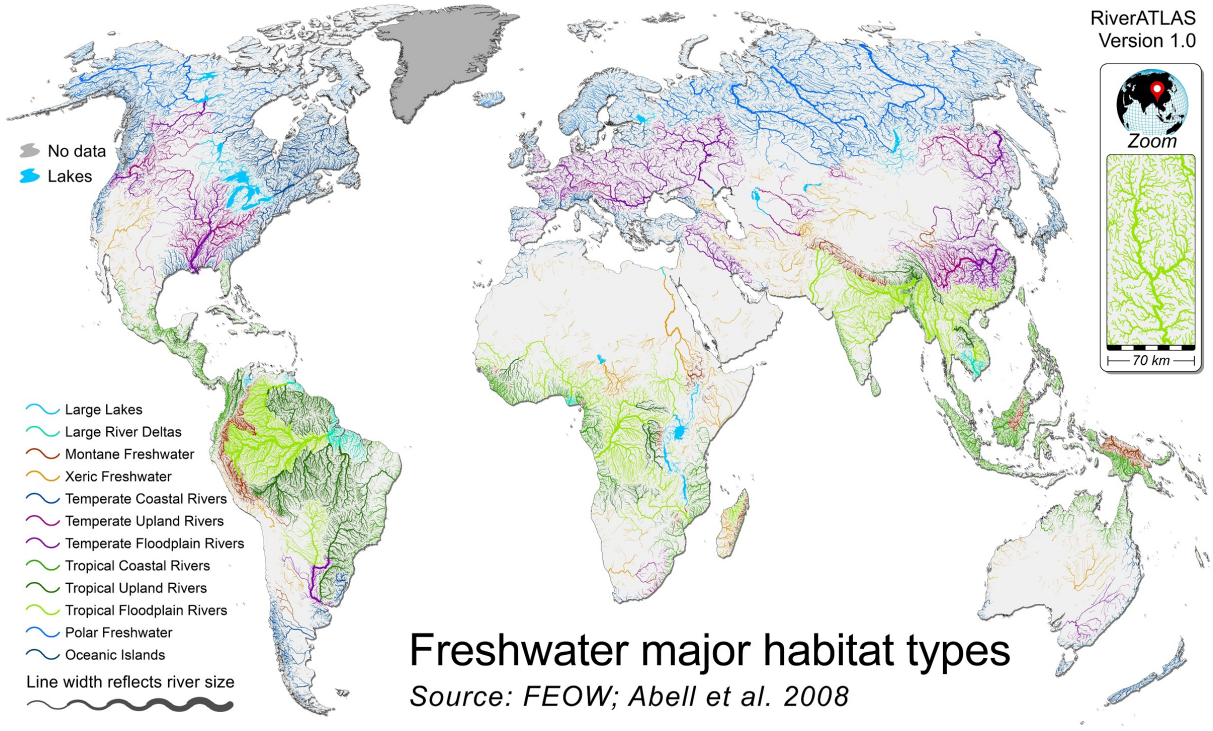
***Citation:*** Abell et al. 2008 ***Native format:*** Polygons ***Units:*** classes (13)

***Column name*** **fmh_cl_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {mj} spatial majority

***Existing suffixes {xoo}:*** cmj




| | |
|---|---|
| ***Data description*** | The Freshwater Ecoregion of the World (FEOW) dataset by World Wildlife Fund (WWF) and The Nature Conservancy (TNC) contains vector data on the biogeographic regionalization of Earth's freshwater biodiversity based on regional expert knowledge. Biodiversity and threat data were used to distinguish a total of 426 freshwater ecoregions globally which were classified into 13 major habitat types. HydroATLAS uses a slightly updated version with some revised major habitat assignments; this version also includes some additional oceanic islands (which do not represent individual ecoregions and are flagged by ID numbers above 900) bringing the total number of classes to 448. |
| ***Reference*** | Abell, R., Thieme, M.L., Revenga, C., Bryer, M., Kottelat, M., Bogutskaya, N., … & Wikramanayake, E. (2008). Freshwater Ecoregions of the World: A New Map of Biogeographic Units for Freshwater Biodiversity Conservation. BioScience, 58(5), 403-414. |
| ***Website*** | https://www.feow.org/download |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | For legend see file HydroATLAS_v10_Legends.xlsx. |

| | | | |
|---|---|---|---|
| ***Category*** | Landcover | ID-L17 | ***>>> Back to Attribute List*** |

# *Attribute* Freshwater Ecoregions

***Source data*** Freshwater Ecoregions of the World (FEOW)

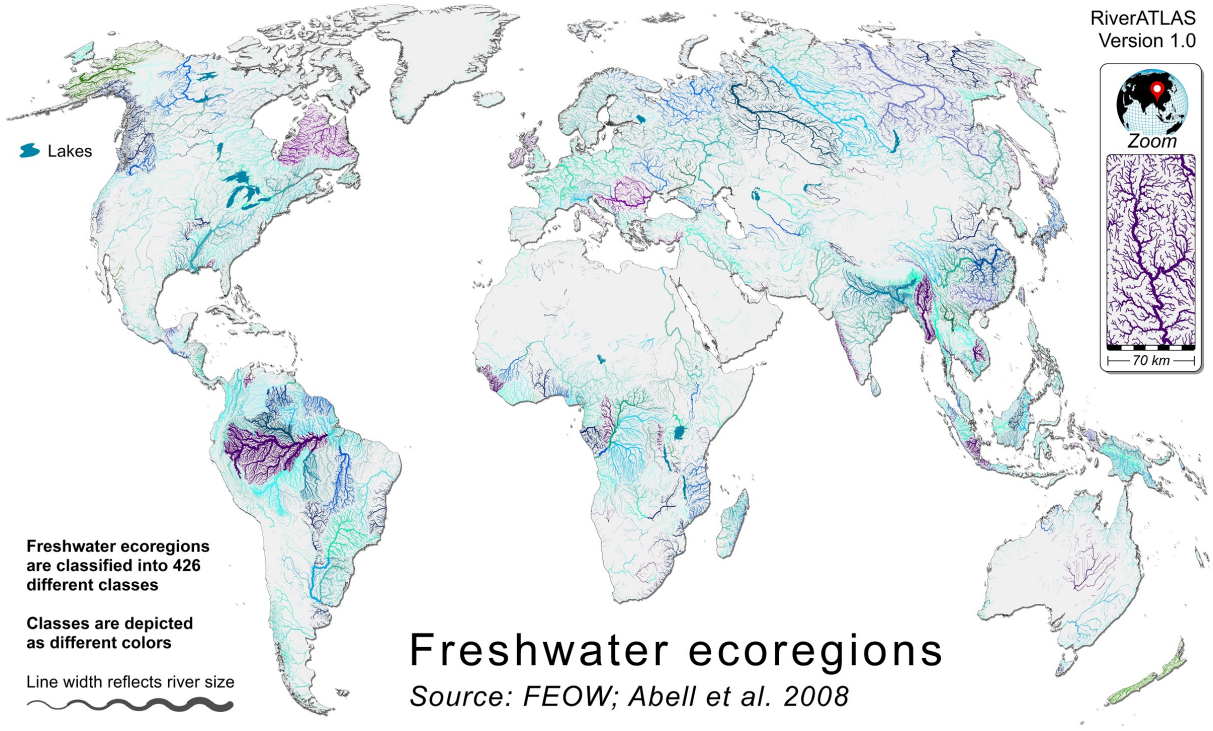
***Citation:*** Abell et al. 2008 ***Native format:*** Polygons ***Units:*** classes (426)

***Column name*** **fec_cl_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {mj} spatial majority

***Existing suffixes {xoo}:*** cmj




| | |
|---|---|
| ***Data description*** | The Freshwater Ecoregion of the World (FEOW) dataset by World Wildlife Fund (WWF) and The Nature Conservancy (TNC) contains vector data on the biogeographic regionalization of Earth's freshwater biodiversity based on regional expert knowledge. Biodiversity and threat data were used to distinguish a total of 426 freshwater ecoregions globally which were classified into 13 major habitat types. HydroATLAS uses a slightly updated version with some revised major habitat assignments; this version also includes some additional oceanic islands (which do not represent individual ecoregions and are flagged by ID numbers above 900) bringing the total number of classes to 448. |
| ***Reference*** | Abell, R., Thieme, M.L., Revenga, C., Bryer, M., Kottelat, M., Bogutskaya, N., … & Wikramanayake, E. (2008). Freshwater Ecoregions of the World: A New Map of Biogeographic Units for Freshwater Biodiversity Conservation. BioScience, 58(5), 403-414. |
| ***Website*** | https://www.feow.org/download |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | For legend see file HydroATLAS_v10_Legends.xlsx. |

| | | | |
|---|---|---|---|
| ***Category*** | Soils & Geology | ID-S01 | ***>>> Back to Attribute List*** |

# *Attribute* Clay Fraction in Soil

***Source data*** SoilGrids1km

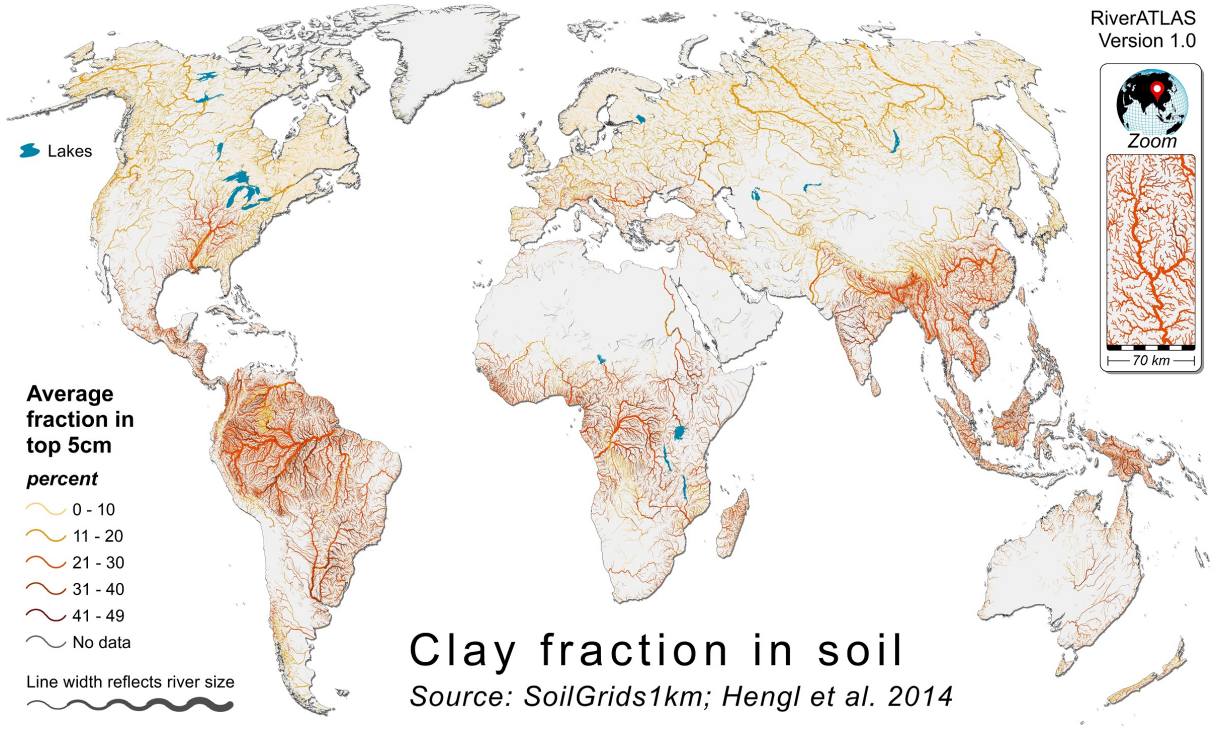
***Citation:*** Hengl et al. 2014 ***Native format:*** 30 arc-second grid ***Units:*** percent

***Column name*** **cly_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** cav | uav




| | |
|---|---|
| ***Data description*** | SoilGrids1km contains spatial predictions for a selection of soil properties (at six standard depths) including sand, silt and clay fractions as well as soil organic carbon stocks. Predictions are based on global spatial prediction models which were fitted, per soil variable, using a compilation of major international soil profile databases (~110,000 soil profiles), and a selection of ~75 global environmental covariates representing soil forming factors. HydroATLAS provides data for the 0-5 cm top soil layer. |
| ***Reference*** | Hengl, T., de Jesus, J.M., MacMillan, R.A., Batjes, N.H., Heuvelink, G.B., Ribeiro, E., Samuel-Rosa, A., Kempen, B., Leenaars, J., Walsh, M., Gonzalez, M.R. (2014). SoilGrids1km—global soil information based on automated mapping. PLoS ONE, 9(8), e105992. doi:10.1371/journal.pone.0105992 |
| ***Website*** | http://isric.org/explore/soilgrids |
| ***License*** | Open Data Commons Open Database License (ODbL v1.0) |
| ***Additional information*** | Original grid contains NoData pixels (mostly in deserts and within open water surfaces such as lakes) which were excluded from average calculations. Value -9999 indicates that there is no data for the entire spatial unit. |

| | | | |
|---|---|---|---|
| ***Category*** | Soils & Geology | ID-S02 | ***>>> Back to Attribute List*** |

# *Attribute* Silt Fraction in Soil

***Source data*** SoilGrids1km

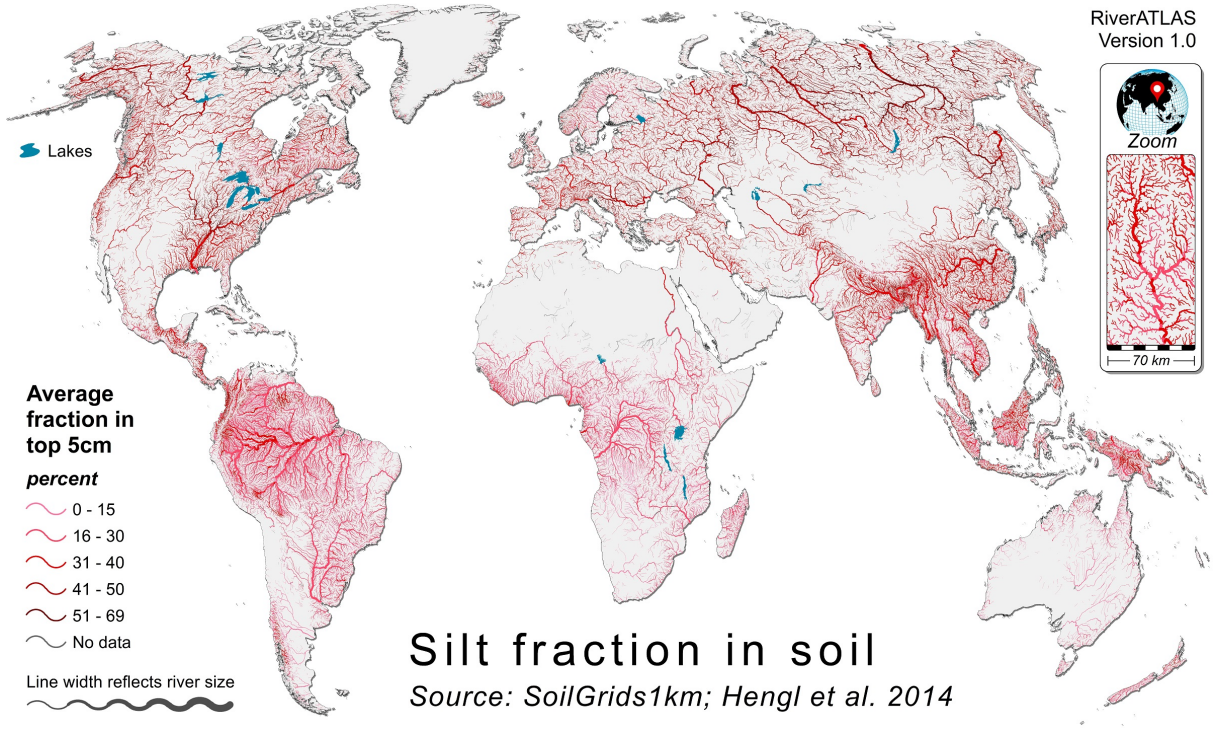
***Citation:*** Hengl et al. 2014 ***Native format:*** 30 arc-second grid ***Units:*** percent

***Column name*** **slt_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** cav | uav




| | |
|---|---|
| ***Data description*** | SoilGrids1km contains spatial predictions for a selection of soil properties (at six standard depths) including sand, silt and clay fractions as well as soil organic carbon stocks. Predictions are based on global spatial prediction models which were fitted, per soil variable, using a compilation of major international soil profile databases (~110,000 soil profiles), and a selection of ~75 global environmental covariates representing soil forming factors. HydroATLAS provides data for the 0-5 cm top soil layer. |
| ***Reference*** | Hengl, T., de Jesus, J.M., MacMillan, R.A., Batjes, N.H., Heuvelink, G.B., Ribeiro, E., Samuel-Rosa, A., Kempen, B., Leenaars, J., Walsh, M., Gonzalez, M.R. (2014). SoilGrids1km—global soil information based on automated mapping. PLoS ONE, 9(8), e105992. doi:10.1371/journal.pone.0105992 |
| ***Website*** | http://isric.org/explore/soilgrids |
| ***License*** | Open Data Commons Open Database License (ODbL v1.0) |
| ***Additional information*** | Original grid contains NoData pixels (mostly in deserts and within open water surfaces such as lakes) which were excluded from average calculations. Value -9999 indicates that there is no data for the entire spatial unit. |

| | | | |
|---|---|---|---|
| ***Category*** | Soils & Geology | ID-S03 | ***>>> Back to Attribute List*** |

# *Attribute* Sand Fraction in Soil

***Source data*** SoilGrids1km

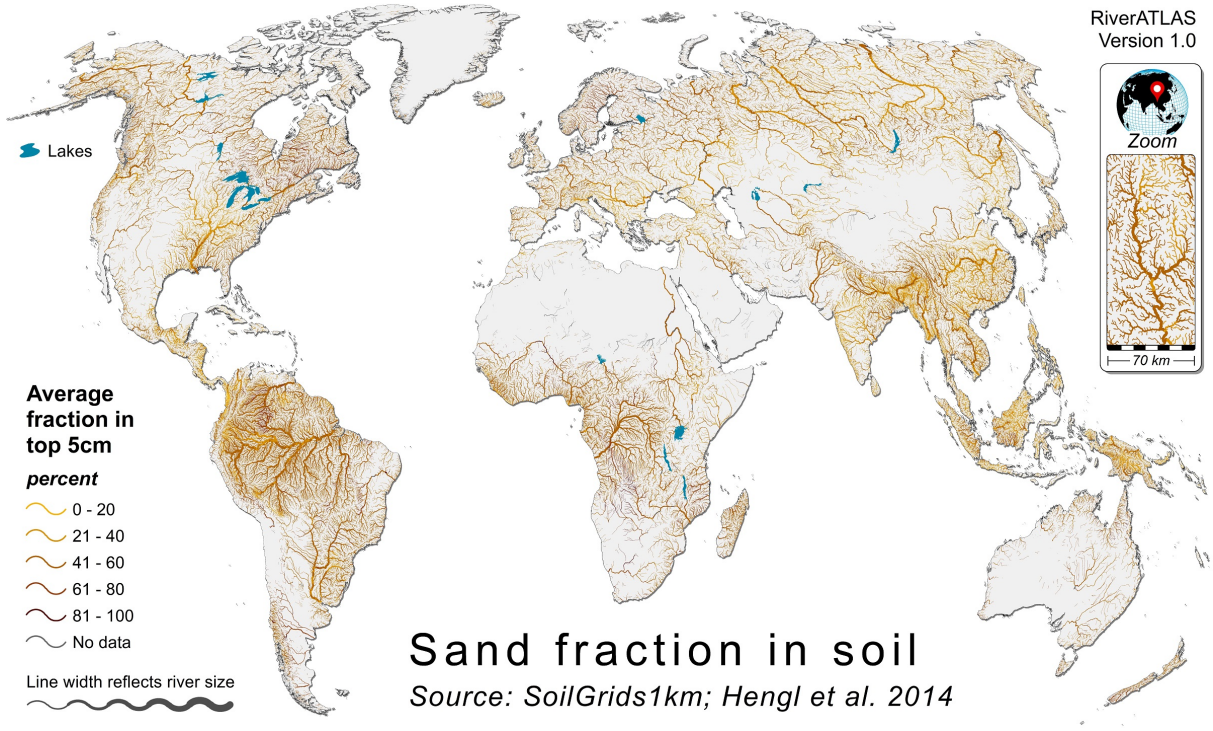
***Citation:*** Hengl et al. 2014 ***Native format:*** 30 arc-second grid ***Units:*** percent

***Column name*** **snd_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** cav | uav




| | |
|---|---|
| ***Data description*** | SoilGrids1km contains spatial predictions for a selection of soil properties (at six standard depths) including sand, silt and clay fractions as well as soil organic carbon stocks. Predictions are based on global spatial prediction models which were fitted, per soil variable, using a compilation of major international soil profile databases (~110,000 soil profiles), and a selection of ~75 global environmental covariates representing soil forming factors. HydroATLAS provides data for the 0-5 cm top soil layer. |
| ***Reference*** | Hengl, T., de Jesus, J.M., MacMillan, R.A., Batjes, N.H., Heuvelink, G.B., Ribeiro, E., Samuel-Rosa, A., Kempen, B., Leenaars, J., Walsh, M., Gonzalez, M.R. (2014). SoilGrids1km—global soil information based on automated mapping. PLoS ONE, 9(8), e105992. doi:10.1371/journal.pone.0105992 |
| ***Website*** | http://isric.org/explore/soilgrids |
| ***License*** | Open Data Commons Open Database License (ODbL v1.0) |
| ***Additional information*** | Original grid contains NoData pixels (mostly in deserts and within open water surfaces such as lakes) which were excluded from average calculations. Value -9999 indicates that there is no data for the entire spatial unit. |

| | | | |
|---|---|---|---|
| ***Category*** | Soils & Geology | ID-S04 | ***>>> Back to Attribute List*** |

# *Attribute* Organic Carbon Content in Soil

***Source data*** SoilGrids1km

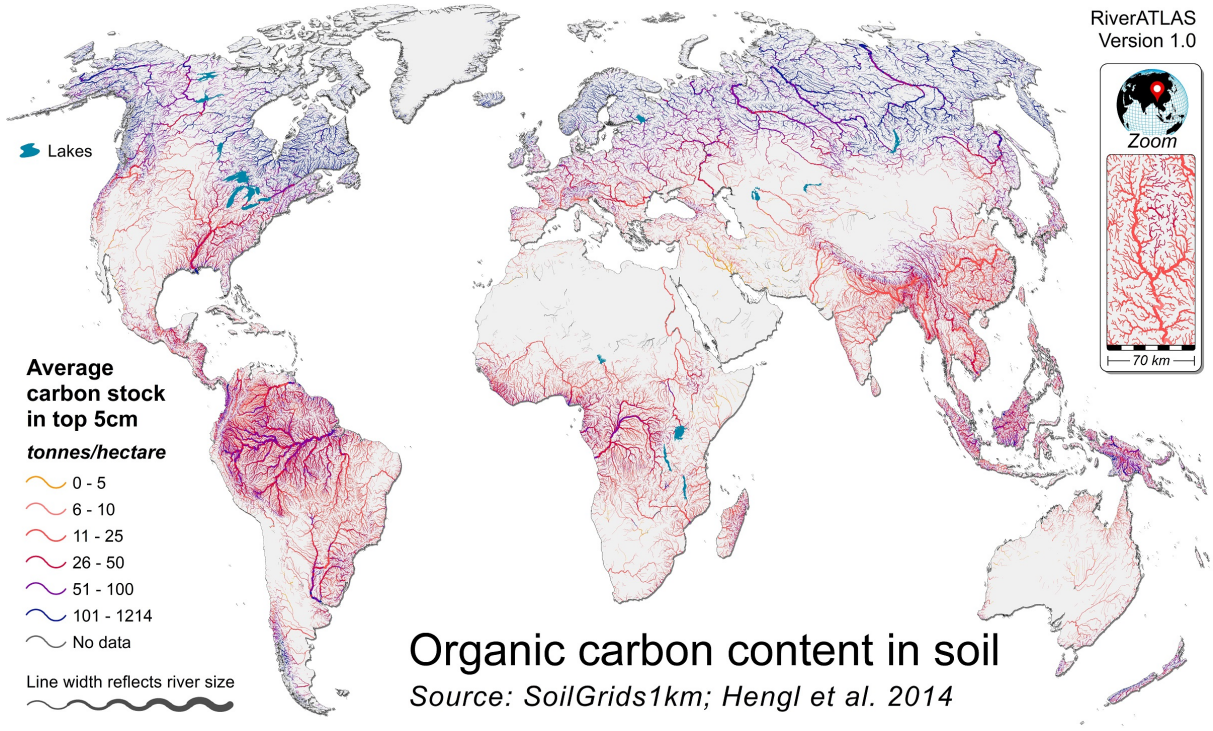
***Citation:*** Hengl et al. 2014 ***Native format:*** 30 arc-second grid ***Units:*** tonnes/hectare

***Column name*** **soc_th_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** cav | uav




| | |
|---|---|
| ***Data description*** | SoilGrids1km contains spatial predictions for a selection of soil properties (at six standard depths) including sand, silt and clay fractions as well as soil organic carbon stocks. Predictions are based on global spatial prediction models which were fitted, per soil variable, using a compilation of major international soil profile databases (~110,000 soil profiles), and a selection of ~75 global environmental covariates representing soil forming factors. HydroATLAS provides data for the 0-5 cm top soil layer. |
| ***Reference*** | Hengl, T., de Jesus, J.M., MacMillan, R.A., Batjes, N.H., Heuvelink, G.B., Ribeiro, E., Samuel-Rosa, A., Kempen, B., Leenaars, J., Walsh, M., Gonzalez, M.R. (2014). SoilGrids1km—global soil information based on automated mapping. PLoS ONE, 9(8), e105992. doi:10.1371/journal.pone.0105992 |
| ***Website*** | http://isric.org/explore/soilgrids |
| ***License*** | Open Data Commons Open Database License (ODbL v1.0) |
| ***Additional information*** | Original grid contains NoData pixels (mostly in deserts and within open water surfaces such as lakes) which were excluded from average calculations. Value -9999 indicates that there is no data for the entire spatial unit. |

| | | | |
|---|---|---|---|
| ***Category*** | Soils & Geology | ID-S05 | ***>>> Back to Attribute List*** |

# *Attribute* Soil Water Content

***Source data*** Global High-Resolution Soil-Water Balance

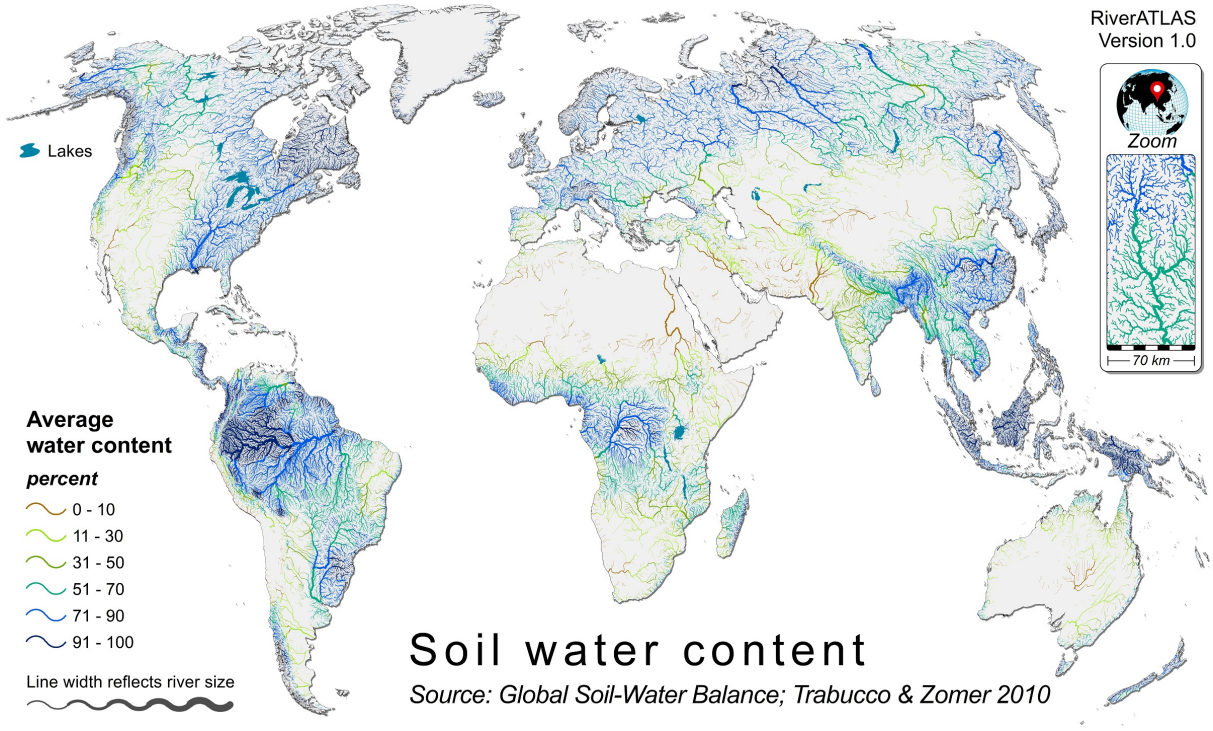
***Citation:*** Trabucco & Zomer 2010 ***Native format:*** 30 arc-second grid ***Units:*** percent

***Column name*** **swc_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {yr} annual average | {01-12} monthly average

***Existing suffixes {xoo}:*** cyr | c01-c12 | uyr




| | |
|---|---|
| ***Data description*** | Soil water content is provided as part of the Global High-Resolution Soil-Water Balance dataset which contains gridded estimates of actual evapotranspiration and soil water deficit. The dataset defines the monthly fraction of soil water content available for evapotranspiration processes (as a percentage of the maximum soil water content). It is therefore a measure of soil stress, and equal to the soil water stress coefficient as a percentage. This dataset utilizes the WorldClim and Global-PET databases as primary input. The results highlight specifically the climatic influence on hydrological dimensions that regulate vegetation suitability. |
| ***Reference*** | Trabucco, A., Zomer, R.J. (2010). Global soil water balance geospatial database. CGIAR Consortium for Spatial Information. Available from the CGIAR-CSI GeoPortal at https://cgiarcsi.community. |
| ***Website*** | https://cgiarcsi.community/data/global-high-resolution-soil-water-balance |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | None |

| | | | |
|---|---|---|---|
| ***Category*** | Soils & Geology | ID-S06 | ***>>> Back to Attribute List*** |

## *Attribute* Lithological Classes

***Source data*** Global Lithological Map (GLiM)

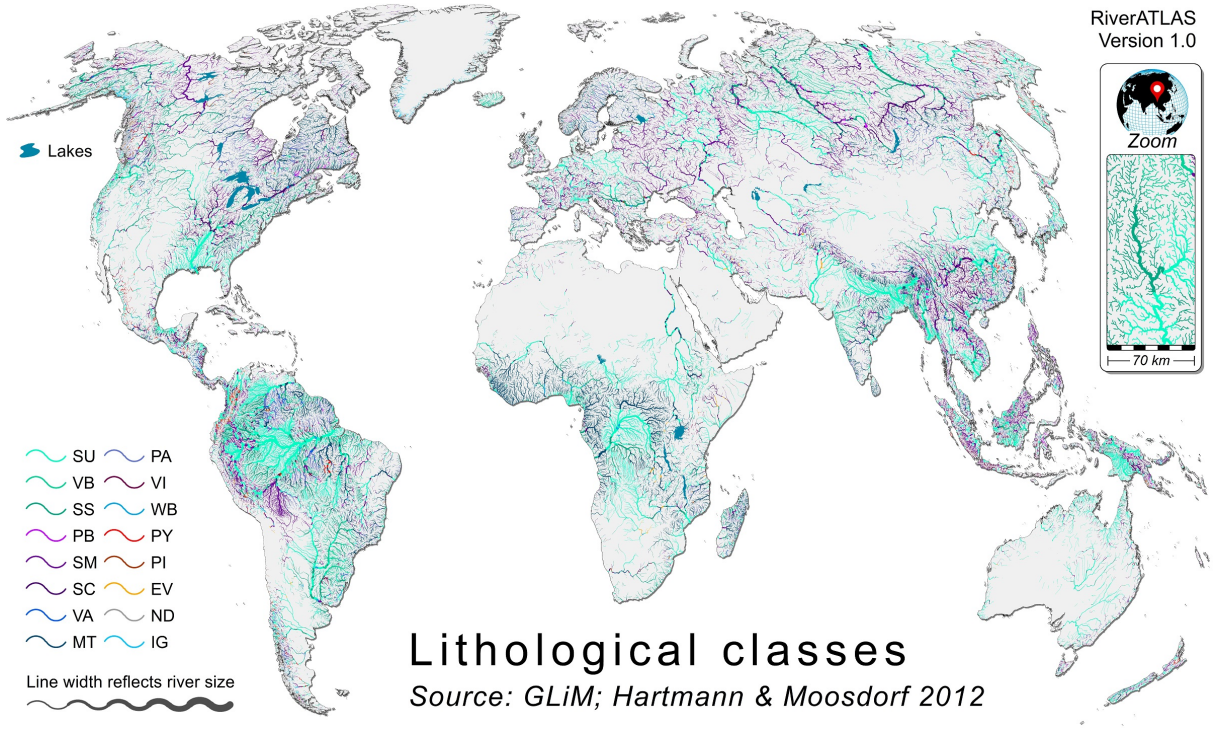
***Citation:*** Hartmann & Moosdorf 2012 ***Native format:*** 30 arc-minute grid ***Units:*** classes (16)

***Column name*** **lit_cl_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {mj} spatial majority

***Existing suffixes {xoo}:*** cmj




| | |
|---|---|
| ***Data description*** | The Global Lithological Map (GLiM) database was assembled from geological maps with a target resolution of 1:1 million and ideally with a national extent or larger, ranging from 1965 to 2012, and translated into lithological information with the help of regional literature. At its most basic level, GLiM contains 16 lithological classes comparable to previously applied definitions in global lithological maps. GLiM represents the rock types of the Earth surface using more than 1.2 million polygons. In HydroATLAS, the publicly availalable simplified grid version at 30 arc-minute resolution was used. |
| ***Reference*** | Hartmann, J., Moosdorf, N. (2012). The new global lithological map database GLiM: A representation of rock properties at the Earth surface. Geochemistry, Geophysics, Geosystems, 13, Q12004. |
| ***Website*** | http://doi.pangaea.de/10.1594/PANGAEA.788537 |
| ***License*** | Original: Creative Commons CC-BY 3.0 -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | For class names see file HydroATLAS_v10_Legends.xlsx. |

| | | | |
|---|---|---|---|
| ***Category*** | Soils & Geology | ID-S07 | ***>>> Back to Attribute List*** |

# *Attribute* Karst Area Extent

***Source data*** World Map of Carbonate Rock Outcrops v3.0

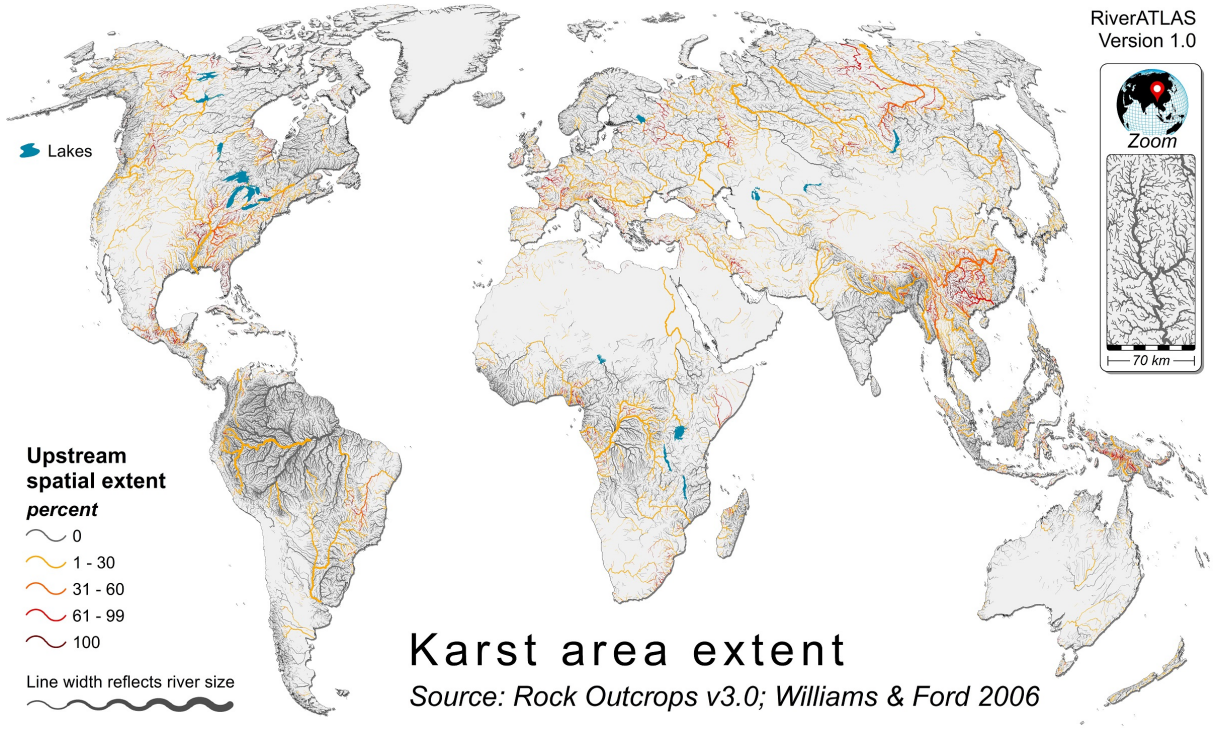
***Citation:*** Williams & Ford 2006 ***Native format:*** Polygons ***Units:*** percent cover

***Column name*** **kar_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {se} spatial extent (%)

***Existing suffixes {xoo}:*** cse | use




***Data description***

The World Map of Carbonate Rock Outcrops represents an upper limit of the area of exposed karst terrain. Extensive karstified carbonate rock also exists in subcrop, but is not mapped in this product. Version 3.0 of the dataset attempts to differentiate those areas where carbonate rocks are relatively pure and continuous from those where they are abundant but discontinuous or impure. The map was assembled using a multitude of sources within a GIS environment.

***Reference***

Williams, P.W., Ford, D.C. (2006). Global distribution of carbonate rocks. Zeitschrift für Geomorphologie, Supplementary Issue, 147, 1-2.

***Website*** http://www.fos.auckland.ac.nz/our_research/karst/

***License*** Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0

***Additional information***

Alternative reference: Ford D., Williams P. (2007). Karst Hydrogeology and Geomorphology. 2nd ed. West Sussex, England: John Wiley & Sons Ltd.

| | | | |
|---|---|---|---|
| ***Category*** | Soils & Geology | ID-S08 | ***>>> Back to Attribute List*** |

# *Attribute* Soil Erosion

***Source data*** RUSLE-based Global Soil Erosion Modelling platform (GloSEM) v1.2

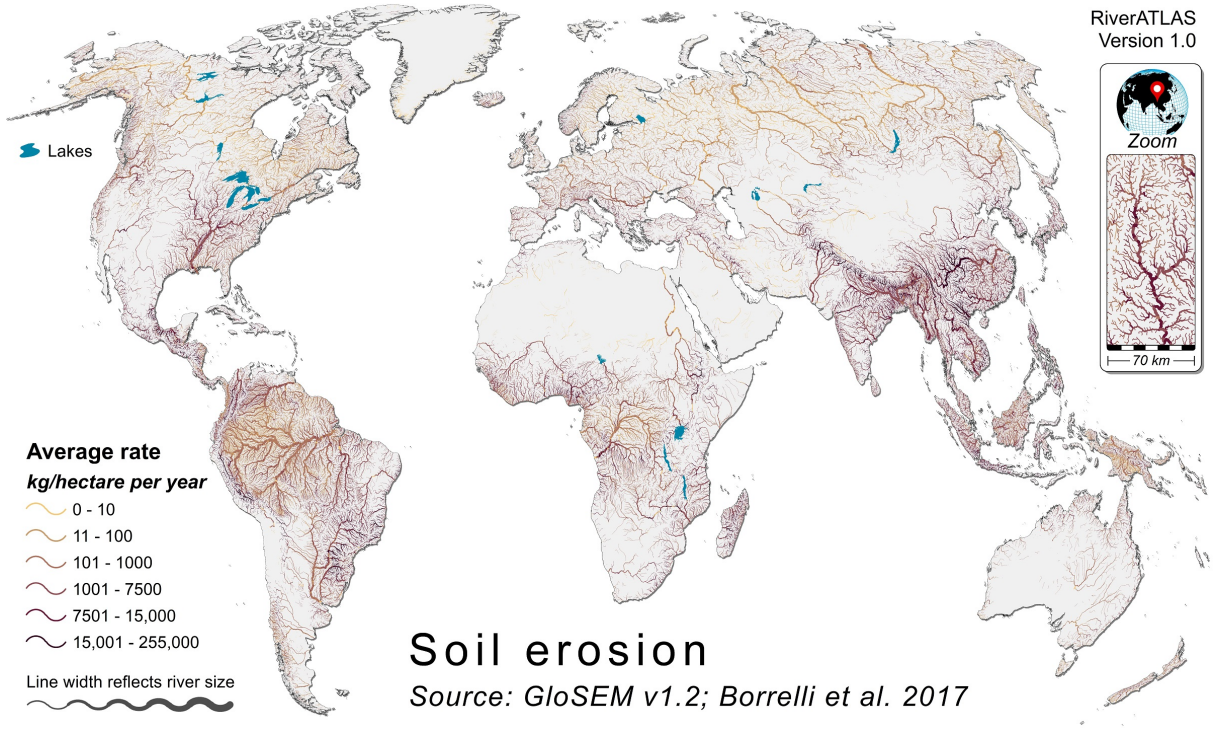
***Citation:*** Borrelli et al. 2017 ***Native format:*** 250-m grid ***Units:*** kg/hectare per year

***Column name*** **ero_kh_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** cav | uav




| | |
|---|---|
| ***Data description*** | GloSEM erosion estimates were produced with a high resolution (250 × 250 m) global potential soil erosion model, using a combination of remote sensing, GIS modelling and census data. The long-term annual soil erosion rates were estimated using an improved large-scale version of the Revised Universal Soil Loss Equation (RUSLE) model. RUSLE belongs to the so-called detachment-limited model types where the soil erosion (expressed as a mass of soil lost per unit area and time) due to inter-rill and rill erosion processes is given by the multiplication of six contributing factors. Consistent with the predictive capacity of the model, soil displacement due to processes such as gullying and tillage erosion is not estimated. |
| ***Reference*** | Borrelli, P., Robinson, D.A., Fleischer, L.R., Lugato, E., Ballabio, C., Alewell, C., Meusburger, K., Modugno, S., Schütt, B., Ferro, V., Bagarello, V., Van Oost, K., Montanarella, L., Panagos, P. (2017). An assessment of the global impact of 21st century land use change on soil erosion. Nature Communication, 8, 2013. |
| ***Website*** | https://doi.org/10.1038/s41467-017-02142-7 |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | GloSEM was developed for the reference years 2001 and 2012 to assess the 21st century human-induced soil erosion by water erosion at a global scale. HydroATLAS provides data for the year 2012. Original GloSEM erosion grid contains NoData pixels (mostly in deserts and within open water surfaces such as lakes) which were set to zero for HydroATLAS calculations. |

| | | | |
|---|---|---|---|
| ***Category*** | Anthropogenic | ID-A01 | ***>>> Back to Attribute List*** |

# *Attribute* Population Count

***Source data*** Gridded Population of the World (GPW) v4

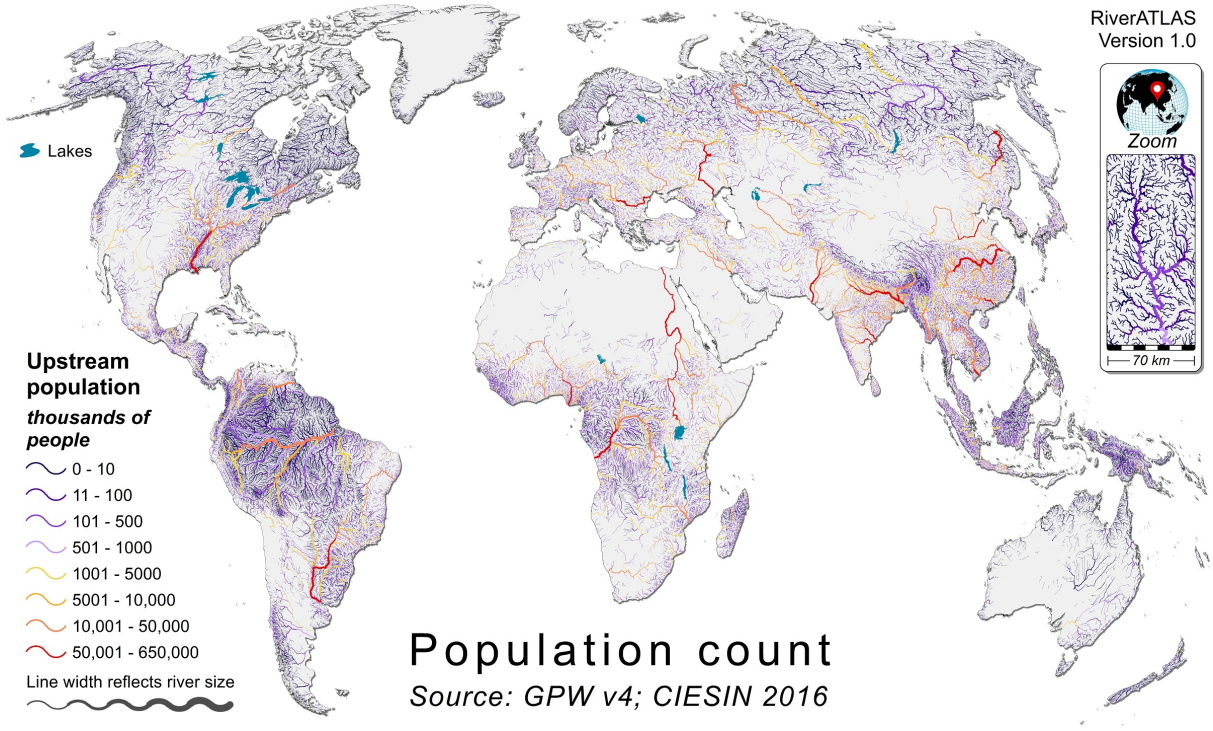
***Citation:*** CIESIN 2016 ***Native format:*** 30 arc-second grid ***Units:*** count (thousands)

***Column name*** **pop_ct_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {su} sum

***Existing suffixes {xoo}:*** csu | usu




| | |
|---|---|
| ***Data description*** | The Gridded Population of the World (GPW) database provides the distribution of humans (counts and densities) on a continuous global surface. For version 4 of GPW, population input data were collected at the most detailed spatial resolution available from the results of the 2010 round of censuses, which occurred between 2005 and 2014. The input data were available for the years 2000, 2005, 2010, and were extrapolated to produce population estimates for 2015, and 2020. HydroATLAS provides data for the year 2010. |
| ***Reference*** | CIESIN (Center for International Earth Science Information Network at Columbia University) (2016). Gridded Population of the World, Version 4 (GPWv4): Population Count. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H4X63JVC. Accessed 23 May 2017. |
| ***Website*** | https://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-count-rev11 |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | People count is stored in thousands of people. Original grid contains NoData pixels which were set to zero for HydroATLAS calculations (i.e. no population). To avoid underestimation along the global coastline due to misalignment of landmasks, any population numbers that were located outside of the HydroATLAS landmask were allocated to the nearest land pixel (within a maximum distance of 20 km). |

| | | | |
|---|---|---|---|
| ***Category*** | Anthropogenic | ID-A02 | ***>>> Back to Attribute List*** |

# *Attribute* Population Density

***Source data*** Gridded Population of the World (GPW) v4

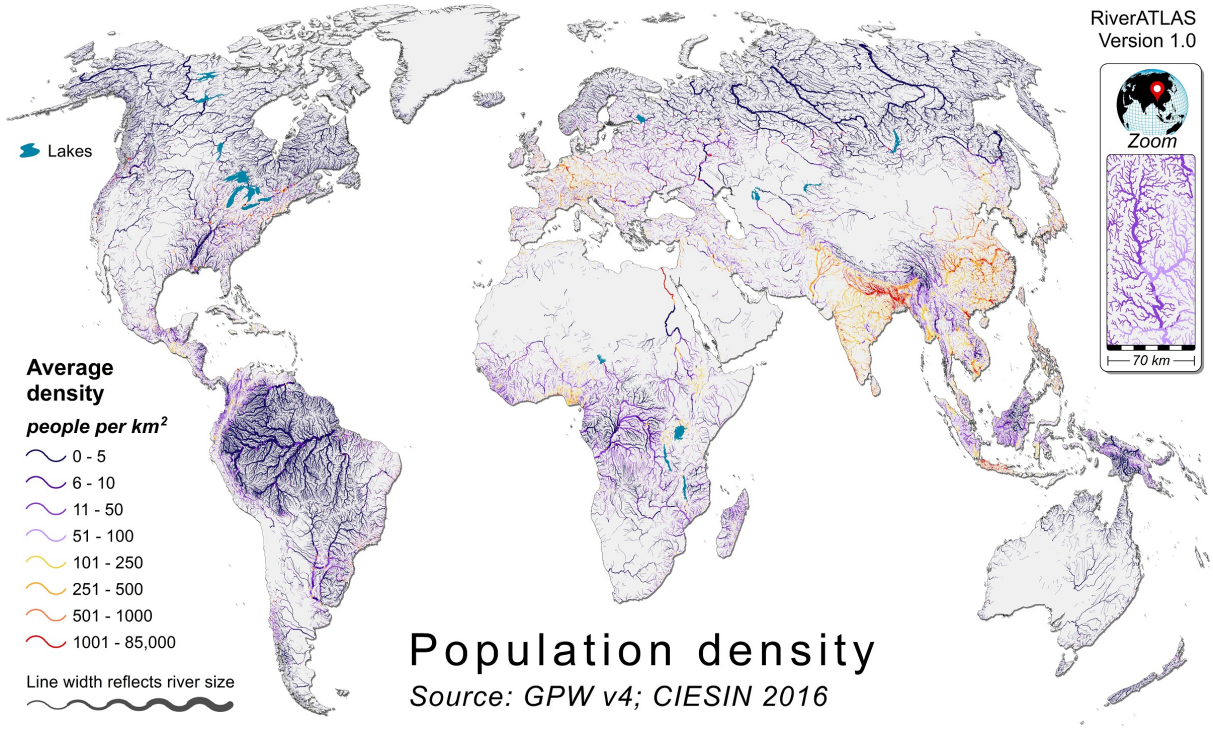
***Citation:*** CIESIN 2016 ***Native format:*** 30 arc-second grid ***Units:*** people per km²

***Column name*** **ppd_pk_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** cav | uav




| | |
|---|---|
| ***Data description*** | The Gridded Population of the World (GPW) database provides the distribution of humans (counts and densities) on a continuous global surface. For version 4 of GPW, population input data were collected at the most detailed spatial resolution available from the results of the 2010 round of censuses, which occurred between 2005 and 2014. The input data were available for the years 2000, 2005, 2010, and were extrapolated to produce population estimates for 2015, and 2020. HydroATLAS provides data for the year 2010. |
| ***Reference*** | CIESIN (Center for International Earth Science Information Network at Columbia University) (2016). Gridded Population of the World, Version 4 (GPWv4): Population Density. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H4X63JVC. Accessed 24 May 2017. |
| ***Website*** | https://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-density-rev11 |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | All 'noData' areas on the original grid were replaced with zero values (i.e. no population). To avoid underestimation along the global coastline due to misalignment of landmasks, any population numbers that were located outside of the HydroATLAS landmask were allocated to the nearest land pixel (within a maximum distance of 20 km). |

| | | | |
|---|---|---|---|
| ***Category*** | Anthropogenic | ID-A03 | ***>>> Back to Attribute List*** |

## *Attribute* Urban Extent

***Source data*** Global Human Settlement (GHS) Settlement Model v1.0 (2016)

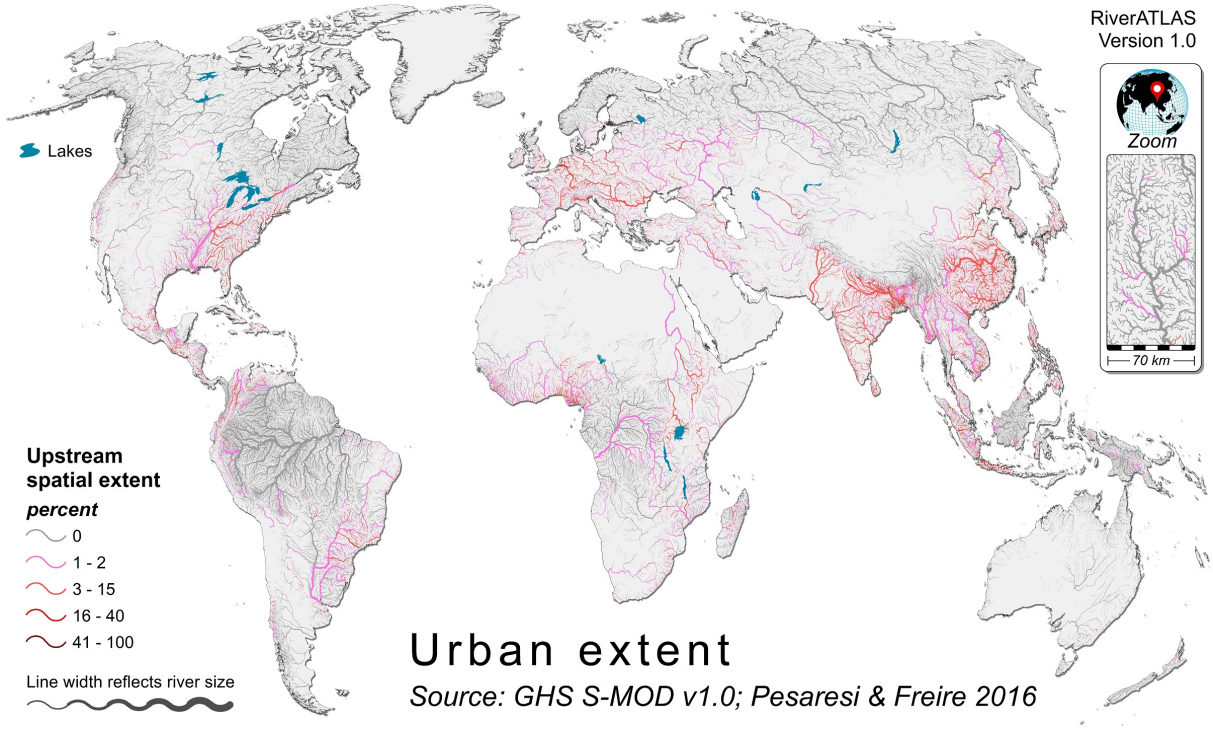
***Citation:*** Pesaresi & Freire 2016 ***Native format:*** 1-km grid ***Units:*** percent cover

***Column name*** **urb_pc_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {se} spatial extent (%)

***Existing suffixes {xoo}:*** cse | use




| | |
|---|---|
| ***Data description*** | The Global Human Settlement (GHS) framework produces global spatial information about the human presence on the planet over time. This achieved in the form of built-up maps, population density maps and settlement maps. This information is generated with evidence-based analytics and knowledge using new spatial data mining technologies. The framework uses heterogeneous data including global archives of fine-scale satellite imagery, census data, and volunteered geographic information. The data is processed fully automatically and generates analytics and knowledge reporting objectively and systematically about the presence of population and built-up infrastructures. |
| ***Reference*** | Pesaresi, M., Freire, S. (2016). GHS Settlement grid following the REGIO model 2014 in application to GHSL Landsat and CIESIN GPW v4-multitemporal (1975-1990-2000-2015). European Commission, Joint Research Centre (JRC). PID: http://data.europa.eu/89h/jrc-ghsl-ghs_smod_pop_globe_r2016a |
| ***Website*** | https://ghsl.jrc.ec.europa.eu/ |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | HydroATLAS uses the settlement model grid (GHS-SMOD) for the year 2015 (dataset name: GHS_SMOD_POP2015_GLOBE_R2016A_54009_1k). Codes 0 (unpopulated) and 1 (rural areas) were classified as rural; and codes 2 (low density clusters) and 3 (high density clusters) were classified as urban. |

| | | | |
|---|---|---|---|
| ***Category*** | Anthropogenic | ID-A04 | ***>>> Back to Attribute List*** |

## *Attribute* Nighttime Lights

***Source data*** DMSP-OLS Nighttime Lights v4

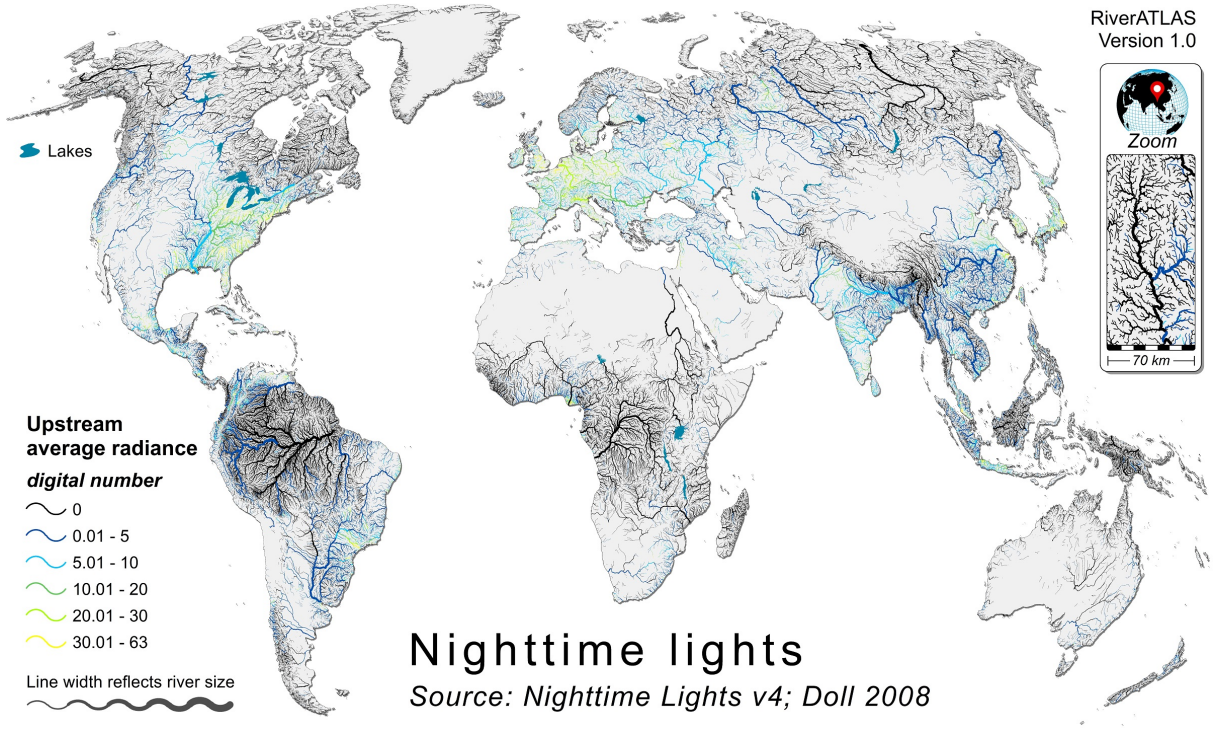
***Citation:*** Doll 2008 ***Native format:*** 30 arc-second grid ***Units:*** index value (x100)

***Column name*** **nli_ix_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** cav | uav




| | |
|---|---|
| ***Data description*** | The Nighttime Lights dataset represents light visible at night generated by human activity, including settlements, gas flaring, or agricultural fires. The data was produced using cloud-free composites from archived remote sensing imagery from the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) at a spatial resolution of 30 arc-seconds. The values represent the product of the average visible band digital number of cloud-free light detections and the percent frequency of light detection. The inclusion of the percent frequency of detection term normalizes the resulting digital values for variations in the persistence of lighting. For instance, the value for a light only detected half the time is discounted by 50%. HydroATLAS provides Nighttime Lights data for 2008. |
| ***Reference*** | Doll, C.N. (2008). CIESIN thematic guide to night-time light remote sensing and its applications. Center for International Earth Science Information Network of Columbia University, Palisades, NY. |
| ***Website*** | http://ngdc.noaa.gov/eog/dmsp/downloadV4composites.html#AXP |
| ***License*** | Original: Public Domain -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | In the stored data, index values ('digital numbers' ranging from 0 to 63) were multiplied by 100 (i.e. value 100 means 1). |

| | | | |
|---|---|---|---|
| ***Category*** | Anthropogenic | ID-A05 | ***>>> Back to Attribute List*** |

# ***Attribute*** Road Density

***Source data*** Global Roads Inventory Project (GRIP) v4

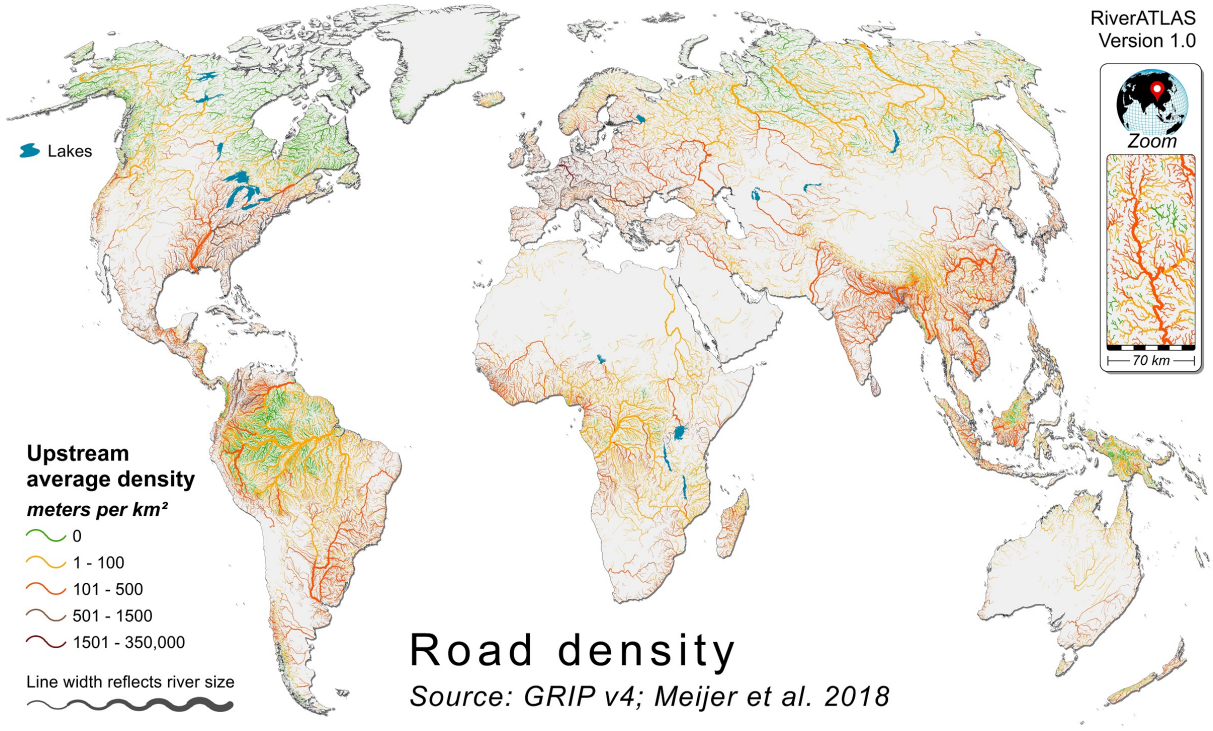
***Citation:*** Meijer et al. 2018 ***Native format:*** 5 arc-min grid ***Units:*** meters per km²

***Column name*** **rdd_mk_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** cav | uav




| | |
|---|---|
| ***Data description*** | The Global Roads Inventory Project (GRIP) dataset was developed to provide a recent and consistent global roads dataset for use in environmental and biodiversity assessment models. The GRIP team gathered, harmonized and integrated nearly 60 geospatial datasets on road infrastructure (from 1997 to current) into a global roads dataset. The resulting dataset includes over 21 million km of roads, distinguished in 5 types. HydroATLAS provides data produced from the 5 arc-minute road density map of GRIP which includes all road types. |
| ***Reference*** | Meijer, J.R., Huijbregts, M.A.J., Schotten, K.C.G.J., Schipper, A.M. (2018). Global patterns of current and future road infrastructure. Environmental Research Letters, 13, 064006. doi:10.1088/1748-9326/aabd42 |
| ***Website*** | https://www.globio.info/download-grip-dataset |
| ***License*** | Open Data Commons Open Database License (ODbL v1.0) |
| ***Additional information*** | Original grid contains NoData pixels which were set to zero for HydroATLAS calculations (i.e. no roads). |

| | | | |
|---|---|---|---|
| ***Category*** | Anthropogenic | ID-A06 | ***>>> Back to Attribute List*** |

# ***Attribute*** Human Footprint

***Source data*** Global Human Footprint v2

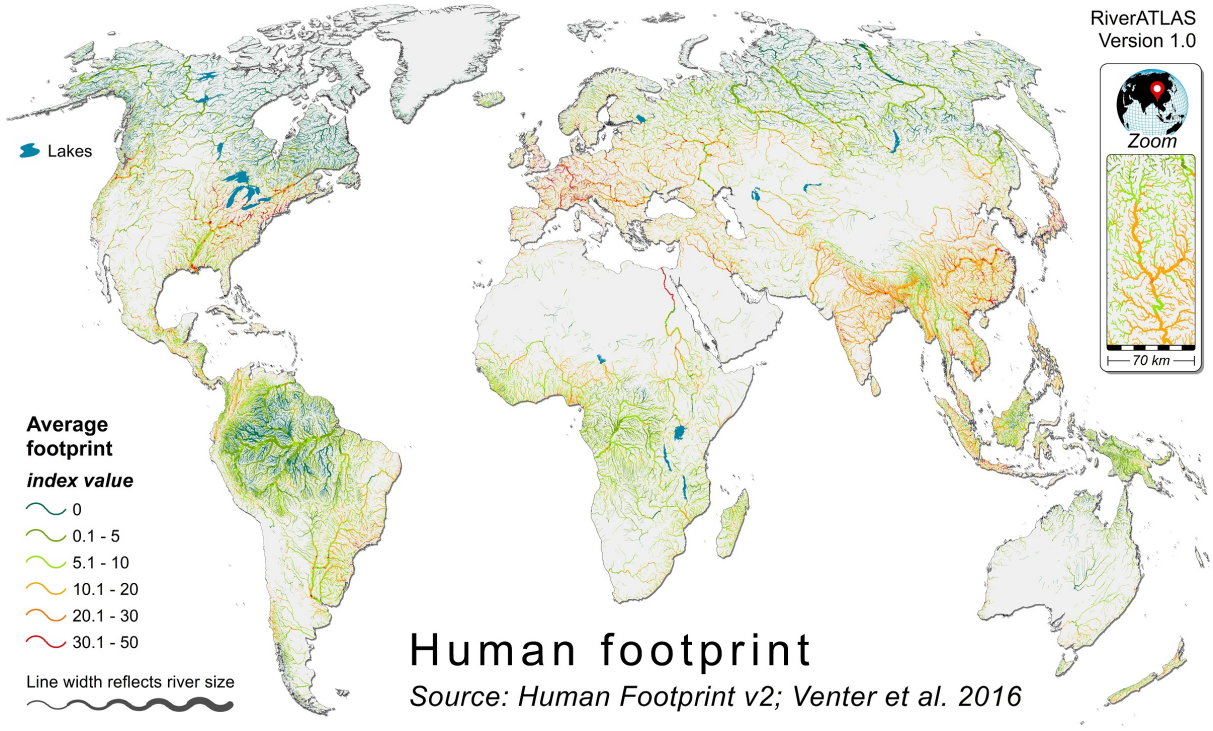
***Citation:*** Venter et al. 2016 ***Native format:*** 30 arc-second grid ***Units:*** index value (x10)

***Column name*** **hft_ix_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment | {u} in total watershed upstream of reach pour point

***Dimension {oo}:*** {93} year 1993 | {09} year 2009

***Existing suffixes {xoo}:*** c93 | u93 | c09 | u09




| | |
|---|---|
| ***Data description*** | The Human Footprint represents the relative human influence in every biome on the land's surface, expressed as a percentage. Remotely-sensed and bottom-up survey information were compiled on eight variables measuring the direct and indirect human pressures on the environment globally in 1993 and 2009. This represents not only the most current information of its type, but also the first temporally-consistent set of Human Footprint maps. Data on human pressures were acquired or developed for: 1) built environments, 2) population density, 3) electric infrastructure, 4) crop lands, 5) pasture lands, 6) roads, 7) railways, and 8) navigable waterways. Pressures were then overlaid to create the standardized Human Footprint maps for all non-Antarctic land areas. |
| ***Reference*** | Venter, O., Sanderson, E.W., Magrach, A., Allan, J.R., Beher, J., Jones, K.R., Possingham, H.P., Laurance, W.F., Wood, P., Fekete, B.M., Levy, M.A., Watson, J.E. 2016. Global terrestrial human footprint maps for 1993 and 2009. Scientific Data, 3,160067. https://doi.org/10.1038/sdata.2016.67. |
| ***Website*** | https://doi.org/10.1038/sdata.2016.67 |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | In the stored data, index values (range 0 to 50) were multiplied by 10 (i.e. value 10 means 1). HydroATLAS provides data for both the years 1993 ('93' in column name) and 2009 ('09' in column name). |

| | | | |
|---|---|---|---|
| ***Category*** | Anthropogenic | ID-A07 | ***>>> Back to Attribute List*** |

# ***Attribute*** Global Administrative Areas

***Source data*** Global Administrative Areas (GADM) v2.0

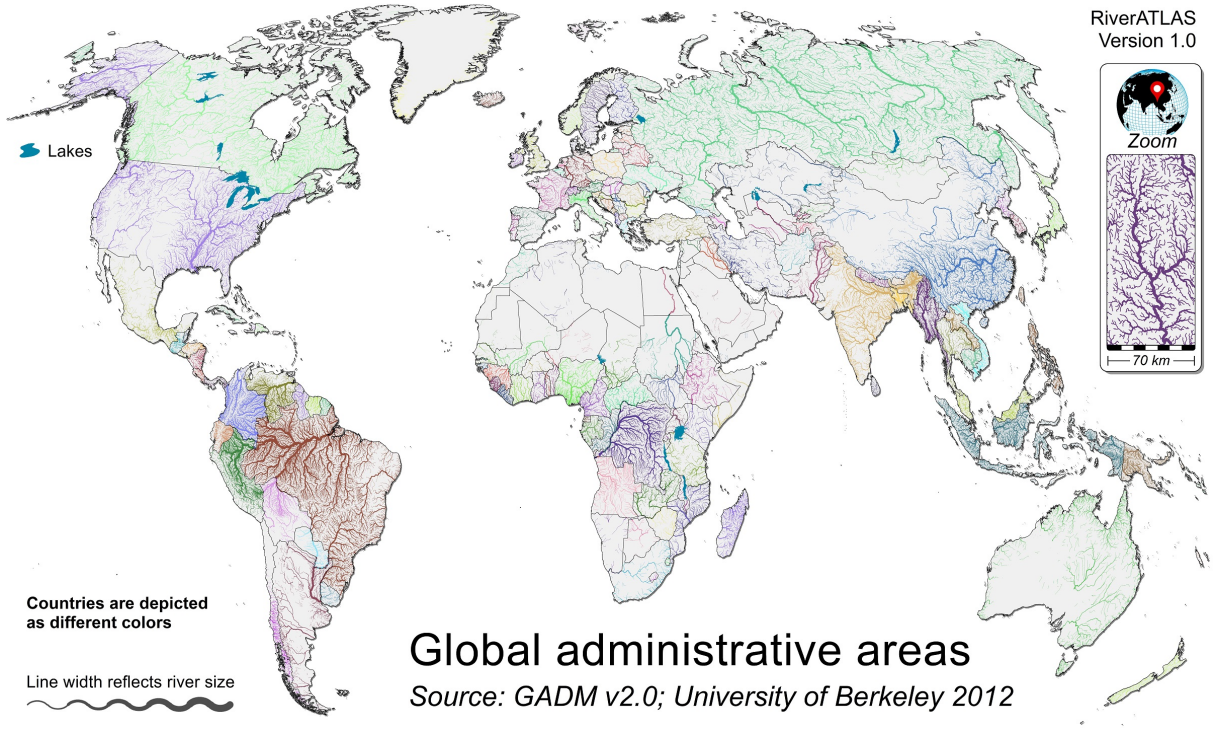
***Citation:*** University of Berkeley 2012 ***Native format:*** Polygons ***Units:*** ID number

***Column name*** **gad_id_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {mj} spatial majority

***Existing suffixes {xoo}:*** cmj




| | |
|---|---|
| ***Data description*** | The Global Administrative Areas (GADM) database compiles the boundaries of the world's administrative areas such as countries and lower level sub-divisions. In GADM, a 'country' is any entity with an ISO country code. However, these may not represent sovereign states. HydroATLAS provides GADM country areas for the year 2012 (GADM version 2.0). Countries are associated to sub-basins and river reaches based on spatial majority, thus shifting the administrative boundaries onto river courses or watershed divides; the results should thus not be used to represent actual country borders. |
| ***Reference*** | University of Berkeley (2012). Database of global administrative areas (GADM). University of Berkeley, Museum of Vertebrate Zoology and the International Rice Research Institute, Berkeley, CA, USA. |
| ***Website*** | http://www.gadm.org/ |
| ***License*** | Original: Free for non-commercial use -- HydroATLAS: Creative Commons CC-BY 4.0 |
| ***Additional information*** | ID values range from 1 to 253. For country names see file HydroATLAS_v10_Legends.xlsx. |

| | | | |
|---|---|---|---|
| ***Category*** | Anthropogenic | ID-A08 | ***>>> Back to Attribute List*** |

# *Attribute* Gross Domestic Product

***Source data*** Gross Domestic Product Purchasing Power Parity (GDP PPP) v2

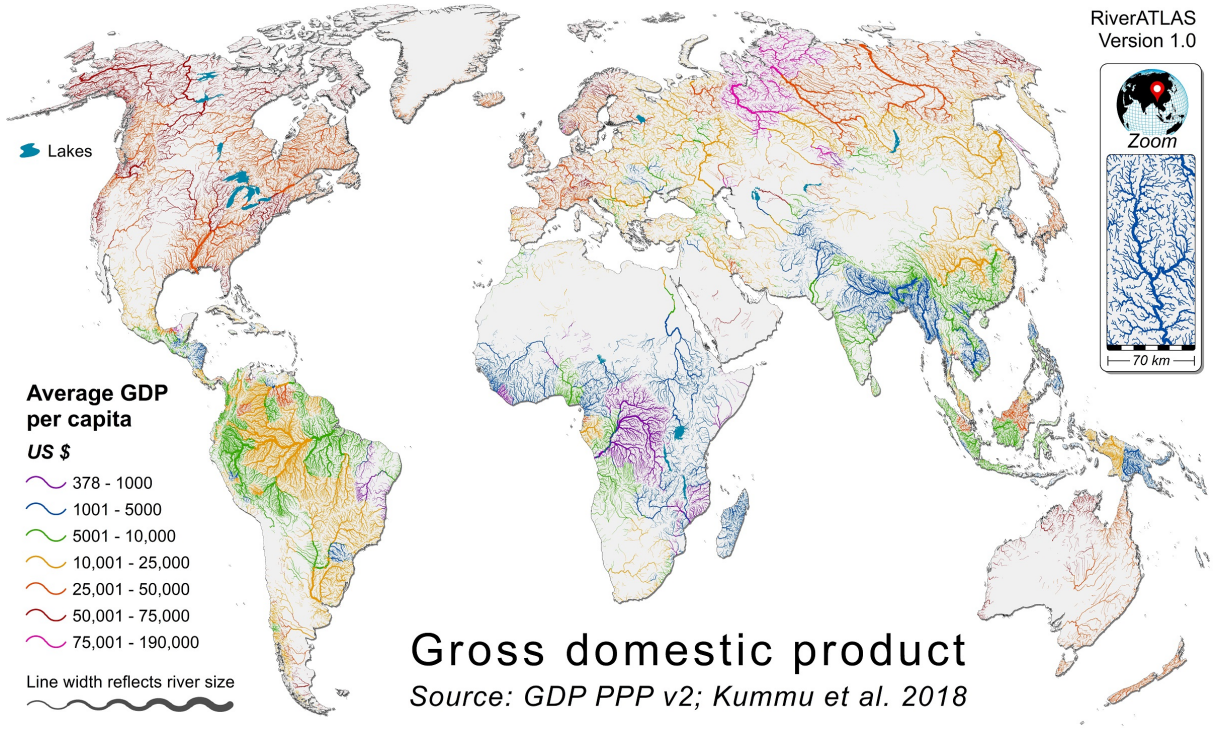
***Citation:*** Kummu et al. 2018 ***Native format:*** 5 arc-min grid ***Units:*** US dollars

***Column name*** **gdp_ud_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {av} average | {su} sum

***Existing suffixes {xoo}:*** cav | csu | usu




| | |
|---|---|
| ***Data description*** | The GDP per capita (PPP - Purchasing Power Parity) dataset represents average gross domestic production per capita in a given administrative area unit. GDP is given in 2011 international US dollars. The original dataset at global extent has a 5 arc-min spatial resolution and is offered as an annual time series for the 26-year period of 1990-2015. In addition to GDP er capita, GDP totals were produced in the original data for 3 time slices (1990, 2000, 2015) at a global 30 arc-second resolution by multiplying GDP per capita values with population counts. HydroATLAS contains data for 2015 for both GDP per capita and GDP totals (see Additional Information for details). |
| ***Reference*** | Kummu, M., Taka, M., Guillaume, J.H.A. (2018) Gridded global datasets for Gross Domestic Product and Human Development Index over 1990-2015. Scientific Data, 5, 180004. https://doi.org/10.1038/sdata.2018.4 |
| ***Website*** | https://doi.org/10.1038/sdata.2018.4 |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | Column name ending in 'av' indicates average 'GDP per capita' values. Column names ending in 'su' indicate 'GDP totals'. |

| | | | |
|---|---|---|---|
| ***Category*** | Anthropogenic | ID-A09 | ***>>> Back to Attribute List*** |

# ***Attribute*** Human Development Index

***Source data*** Human Development Index (HDI) v2

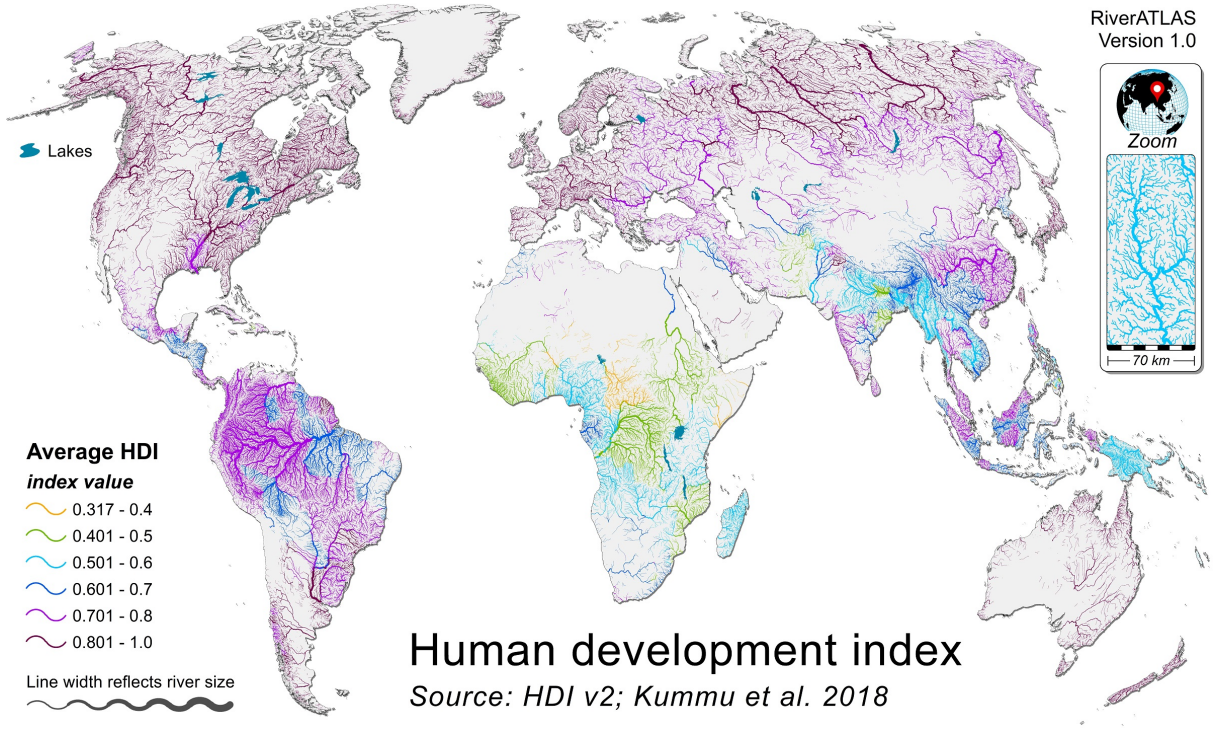
***Citation:*** Kummu et al. 2018 ***Native format:*** 5 arc-min grid ***Units:*** index value (x1000)

***Column name*** **hdi_ix_{xoo}** *(for syntax options of suffix {xoo} see next lines)*

***Spatial extent {x}:*** {c} in reach catchment

***Dimension {oo}:*** {av} average

***Existing suffixes {xoo}:*** cav




| | |
|---|---|
| ***Data description*** | HDI is a composite index of average achievement in key dimensions of human development (dimensionless indicator between 0 and 1). The subnational data for HDI were collected from multiple national-level datasets, and national-level HDI was collected from UNDP. Years with missing data were interpolated over time using thin plate splines, assuming a smooth trend over time. The original dataset has a global extent at 5 arc-min resolution, and the annual data is available for each year over the period 1990-2015. HDI sub-national data covers 39 countries and 66% of global population in 2015. HydroATLAS contains data for 2015. |
| ***Reference*** | Kummu, M., Taka, M., Guillaume, J.H.A. (2018) Gridded global datasets for Gross Domestic Product and Human Development Index over 1990-2015. Scientific Data, 5, 180004. https://doi.org/10.1038/sdata.2018.4 |
| ***Website*** | https://doi.org/10.1038/sdata.2018.4 |
| ***License*** | Creative Commons CC-BY 4.0 |
| ***Additional information*** | In the stored data, index values (range 0 to 1) were multiplied by 1000 (i.e. value 1000 means 1). |