BasinATLAS 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)

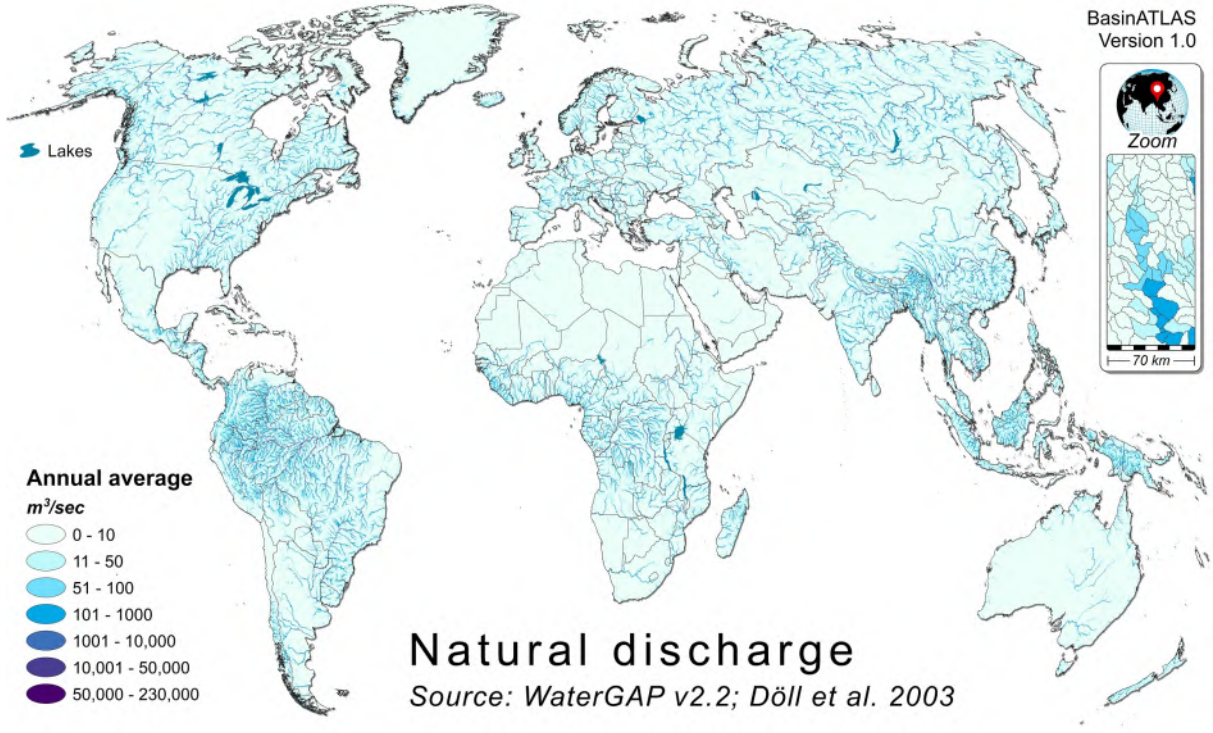
Citation: Döll et al. 2003 ***Native format:*** 15 arc-second grid ***Units:*** cubic meters/second

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

Spatial extent {x}: {p} at sub-basin 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.

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

Attribute Land Surface Runoff

Source data WaterGAP v2.2 (data of 2014)

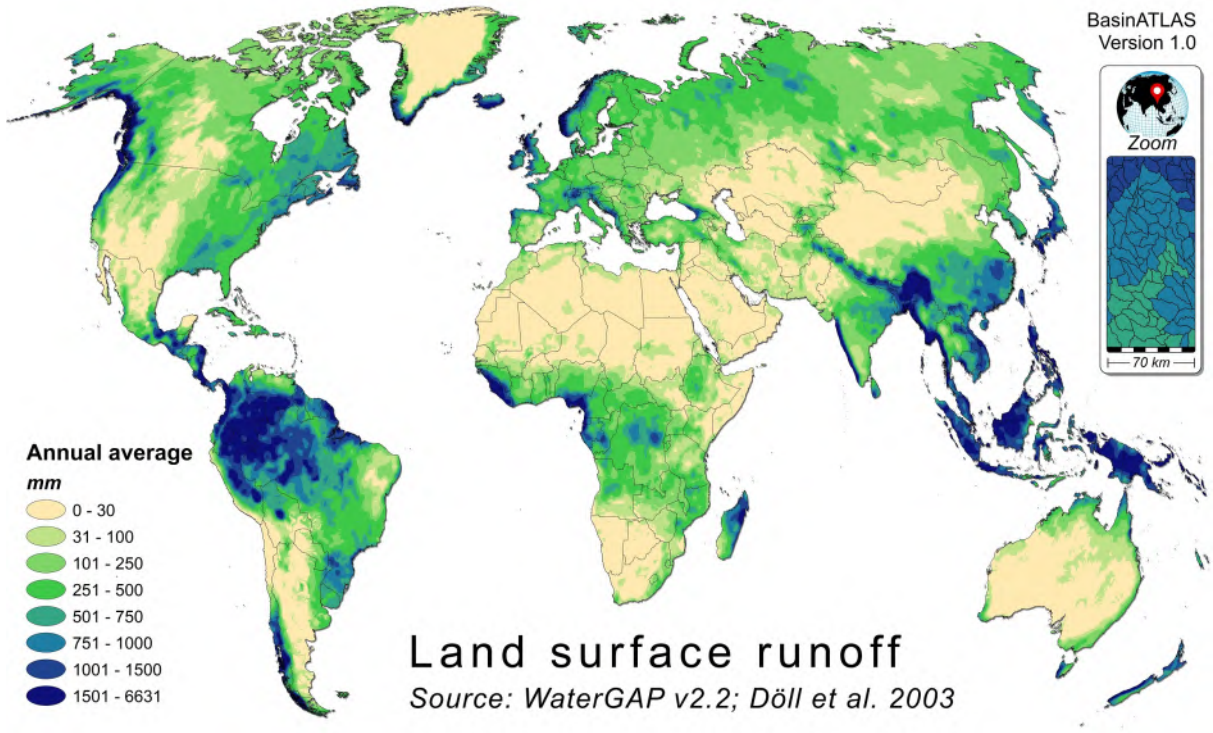
Citation: Döll et al. 2003 ***Native format:*** 15 arc-second grid ***Units:*** millimeters

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {yr} annual average

Existing suffixes {xoo}: syr



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.

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

Attribute Inundation Extent

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

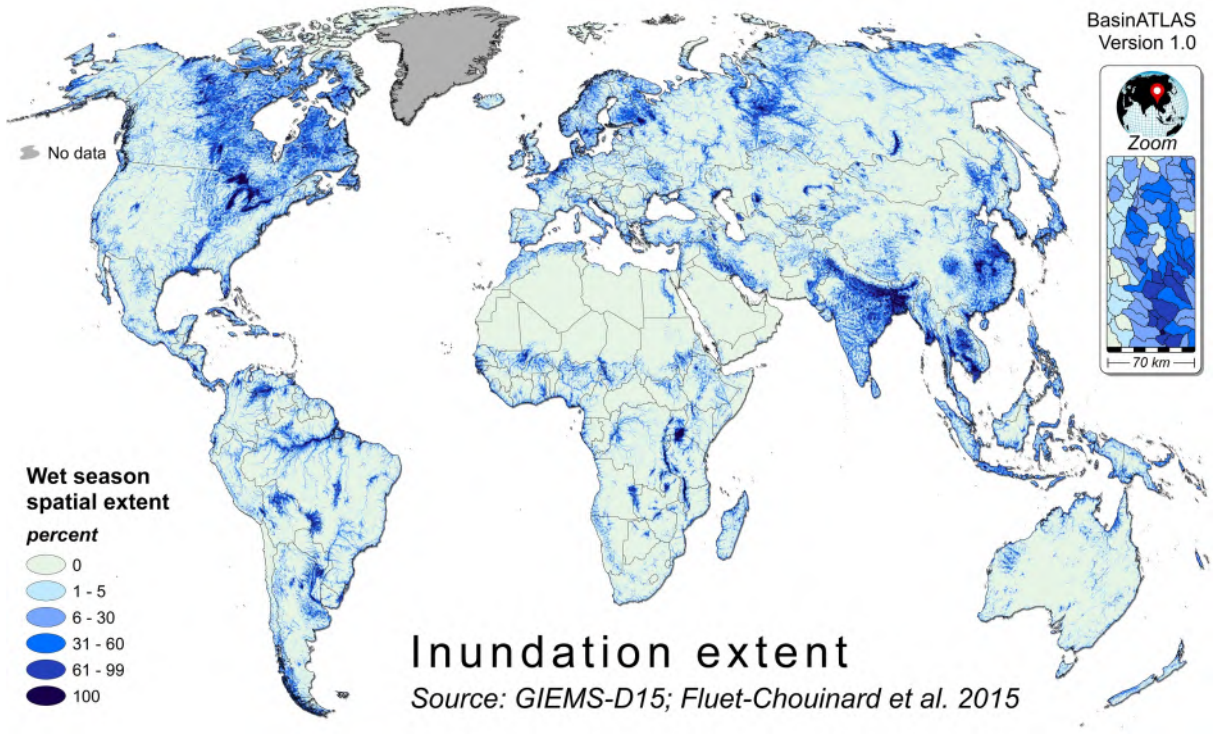
Citation: Fluet-Chouinard et al. 2015 ***Native format:*** 15 arc-second grid ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: smn | smx | slt | 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.

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

Attribute Limnicity (Percent Lake Area)

Source data HydroLAKES

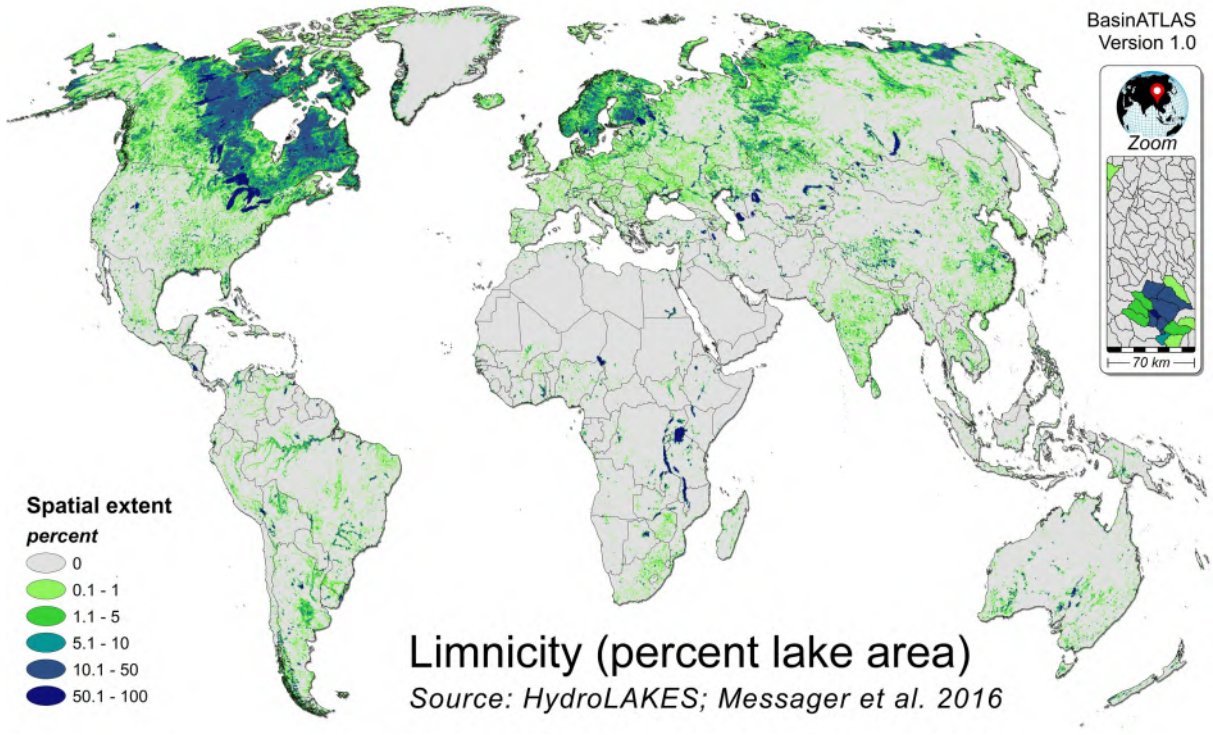
Citation: Messager et al. 2016 ***Native format:*** Polygons ***Units:*** percent cover (x10)

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: sse | 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

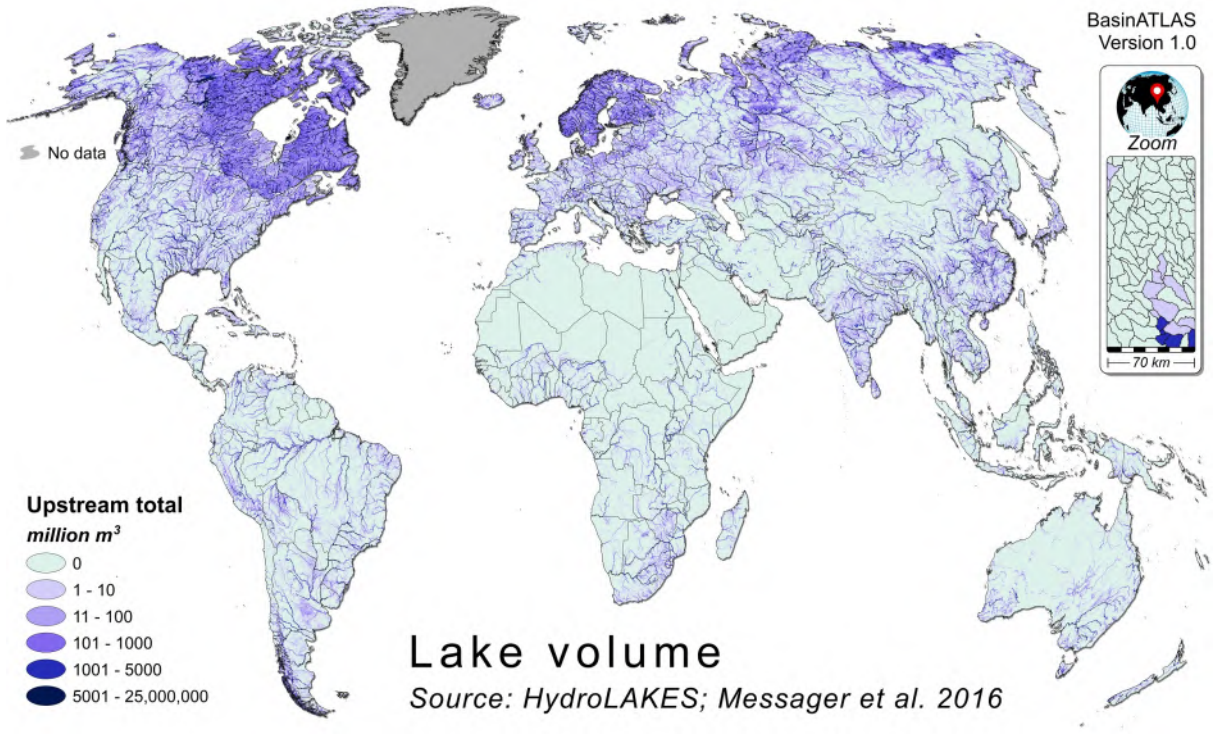
Citation: Messager et al. 2016 ***Native format:*** Polygons ***Units:*** million cubic meters

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

Spatial extent {x}: {u} in total watershed upstream of sub-basin 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

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

Attribute Reservoir Volume

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

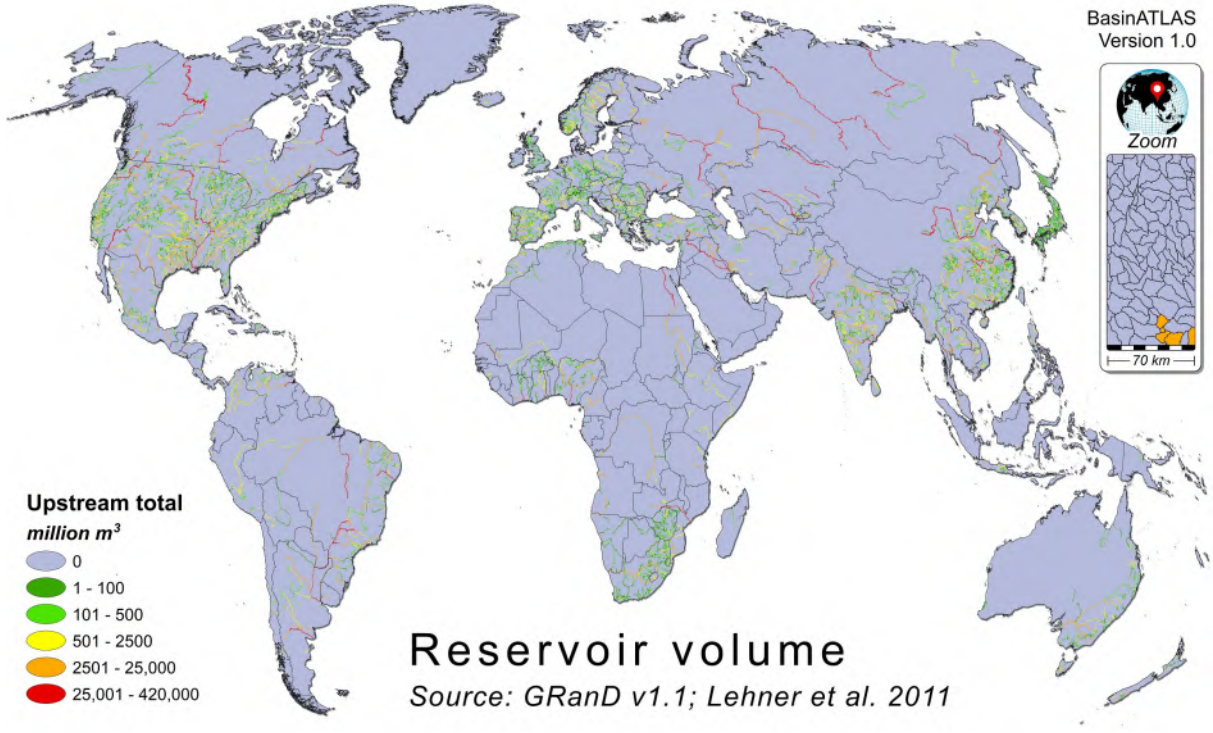
Citation: Lehner et al. 2011 ***Native format:*** Polygons ***Units:*** million cubic meters

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

Spatial extent {x}: {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {su} sum

Existing suffixes {xoo}: usu



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

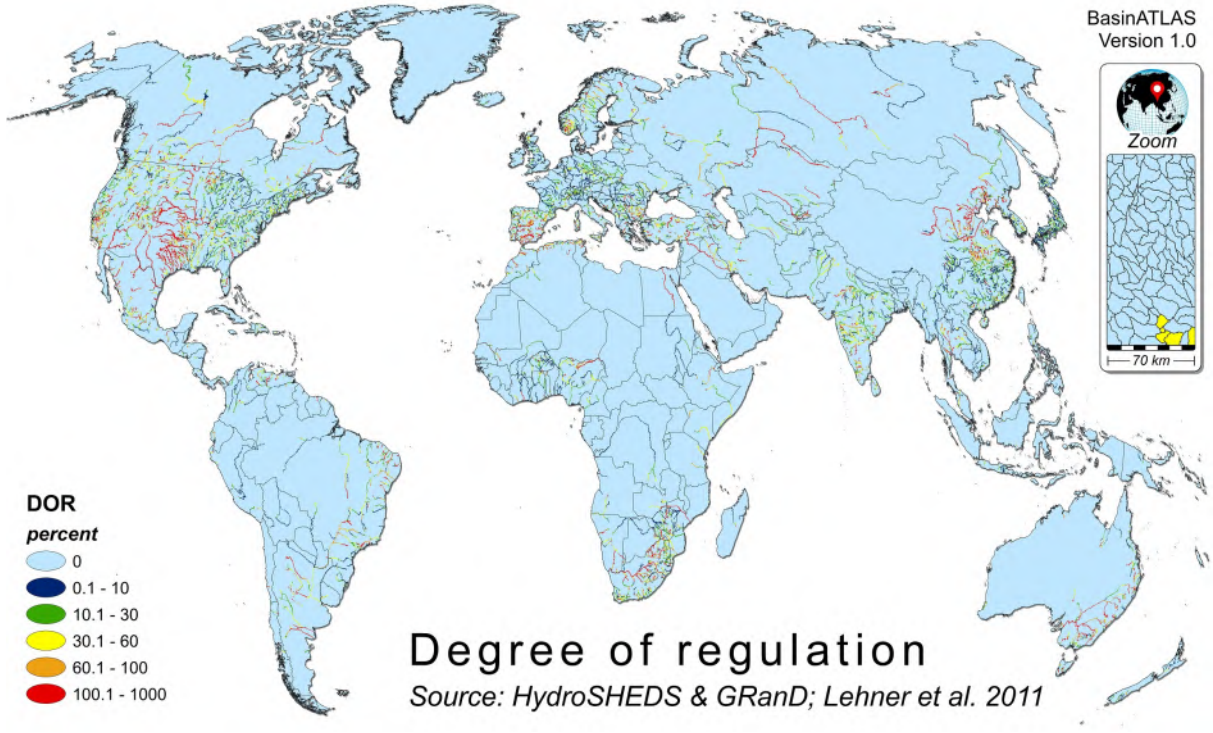
Citation: Lehner et al. 2011 ***Native format:*** Polygons ***Units:*** percent (x10)

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

Spatial extent {x}: {p} at sub-basin 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

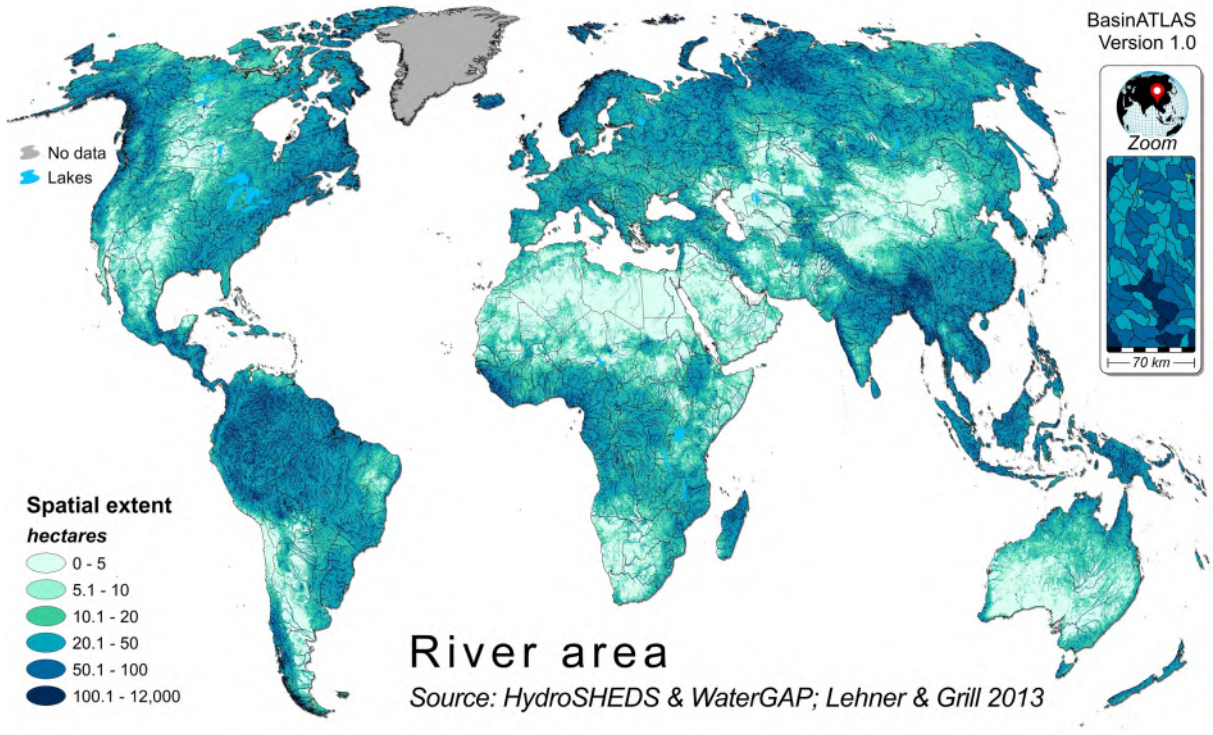
Citation: Lehner & Grill 2013 ***Native format:*** 15 arc-second grid ***Units:*** hectares

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {su} sum

Existing suffixes {xoo}: ssu | 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

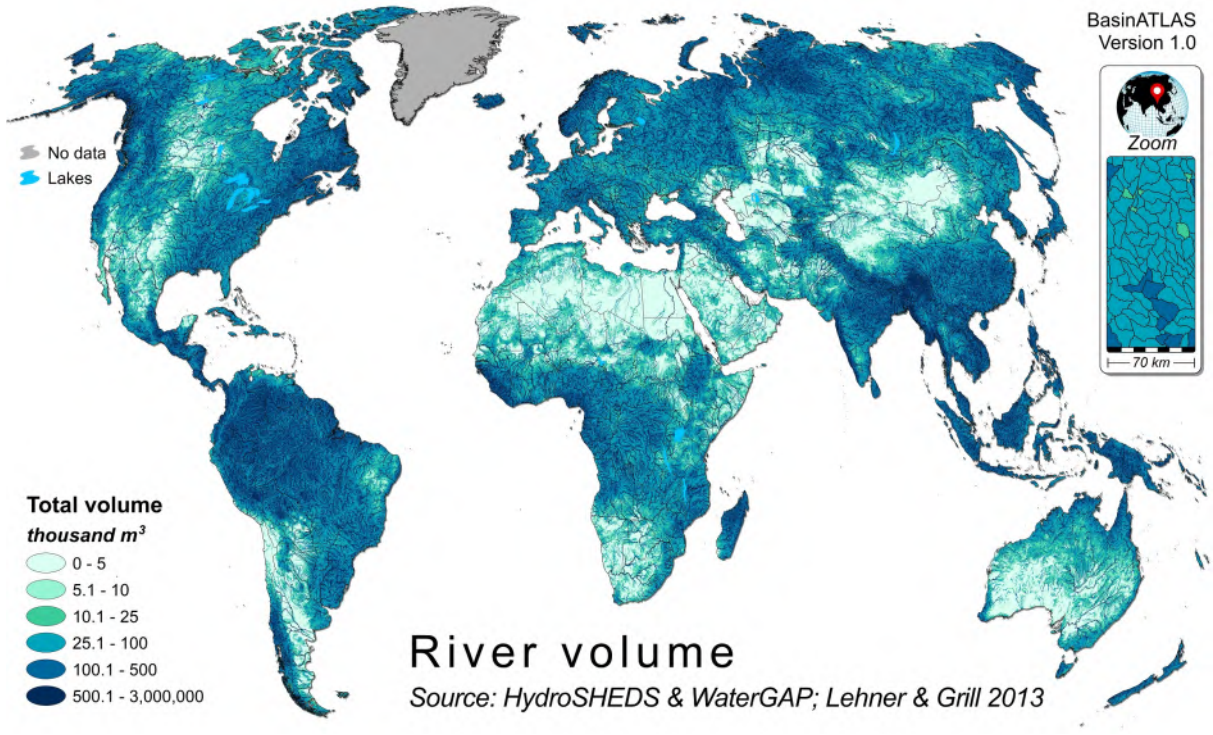
Citation: Lehner & Grill 2013 ***Native format:*** 15 arc-second grid ***Units:*** thousand cubic meters

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {su} sum

Existing suffixes {xoo}: ssu | 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

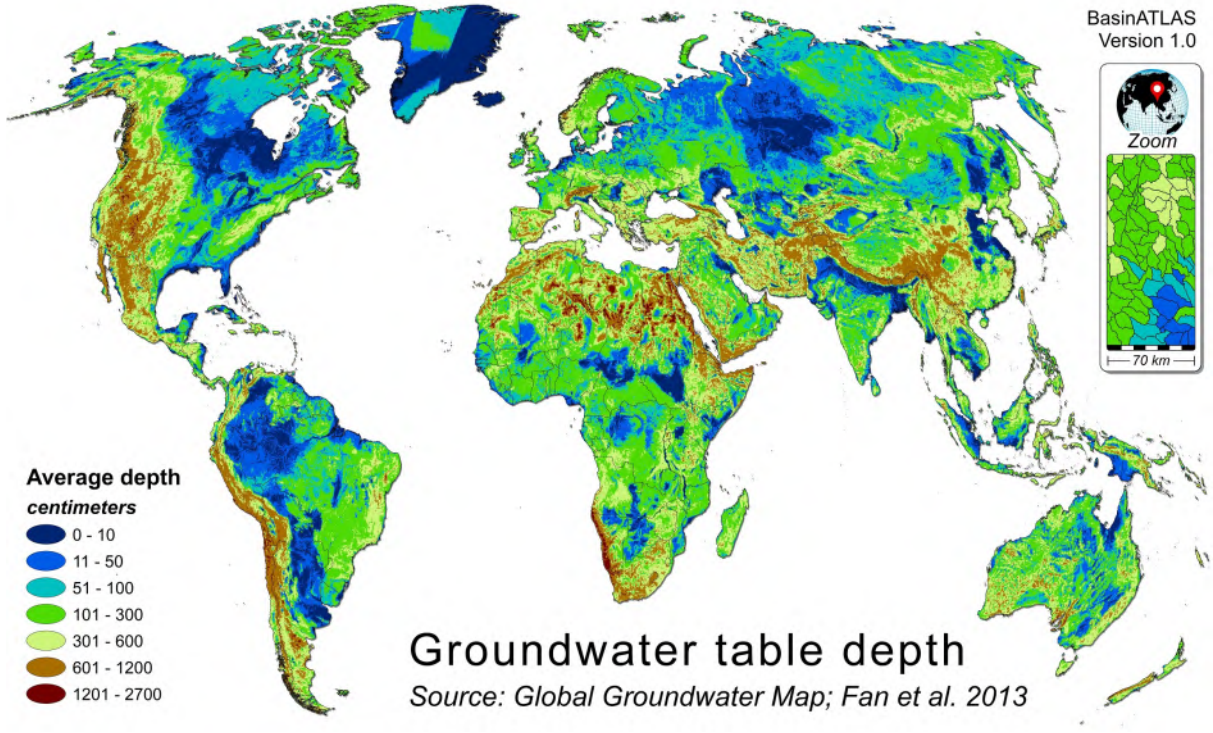
Citation: Fan et al. 2013 ***Native format:*** 30 arc-second grid ***Units:*** centimeters

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav



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

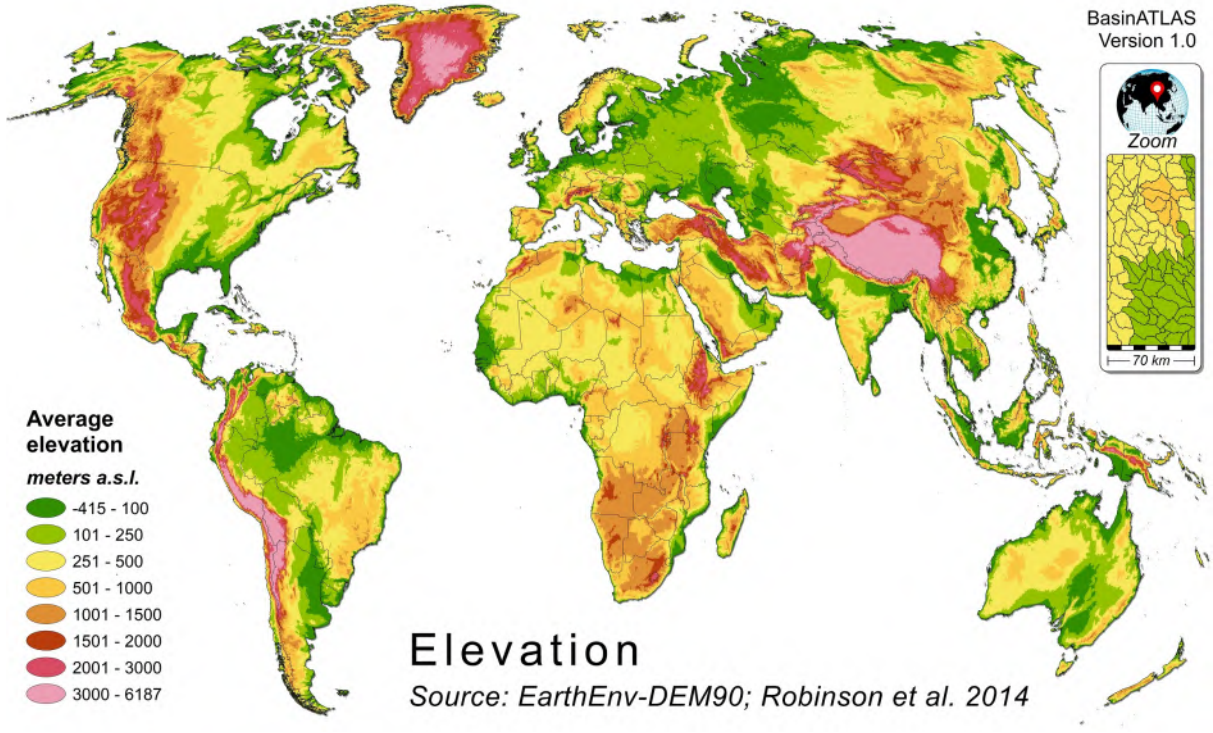
Citation: Robinson et al. 2014 ***Native format:*** 3 arc-second grid ***Units:*** meters a.s.l.

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: sav | smn | smx | 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

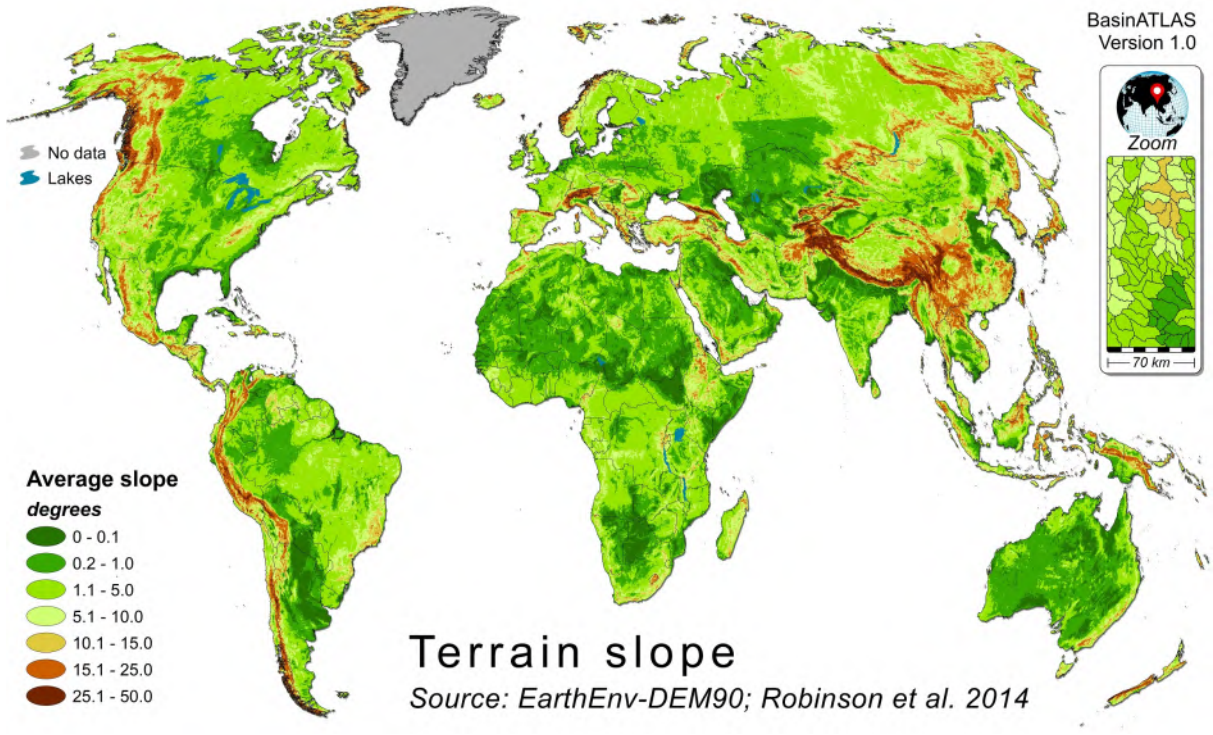
Citation: Robinson et al. 2014 ***Native format:*** 3 arc-second grid ***Units:*** degrees (x10)

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav | 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

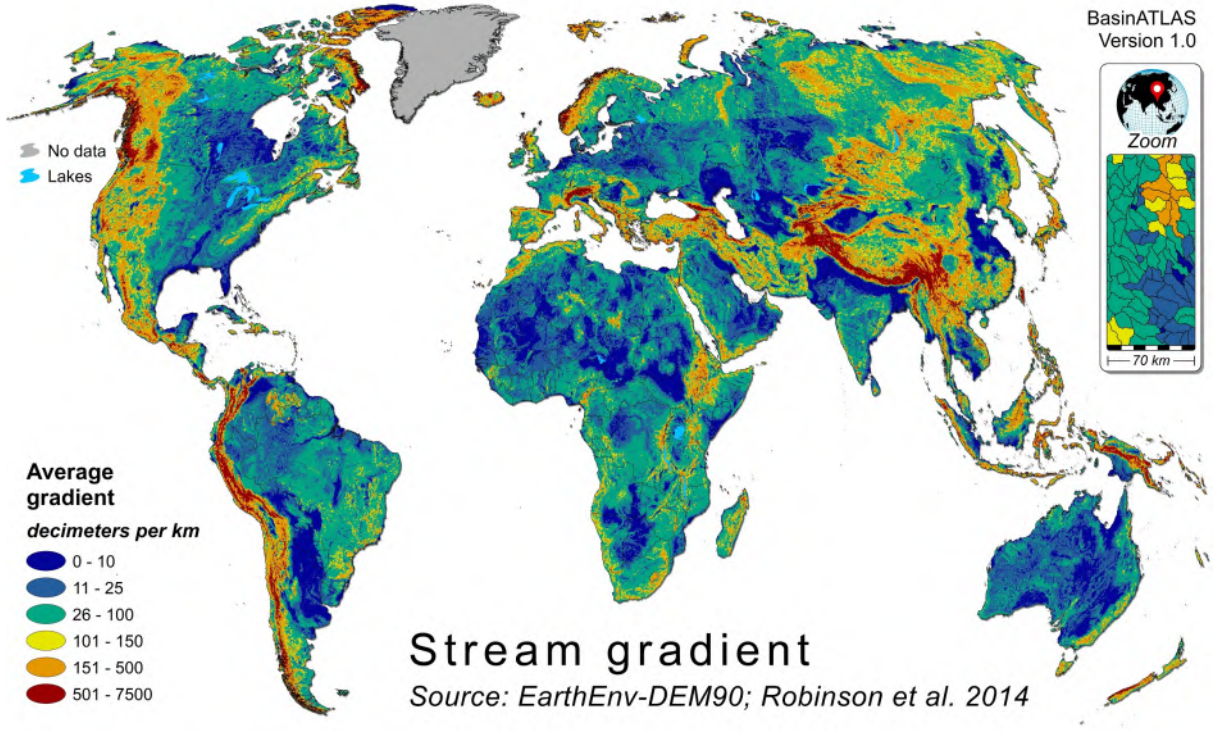
Citation: Robinson et al. 2014 ***Native format:*** 3 arc-second grid ***Units:*** decimeters per km

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav



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)

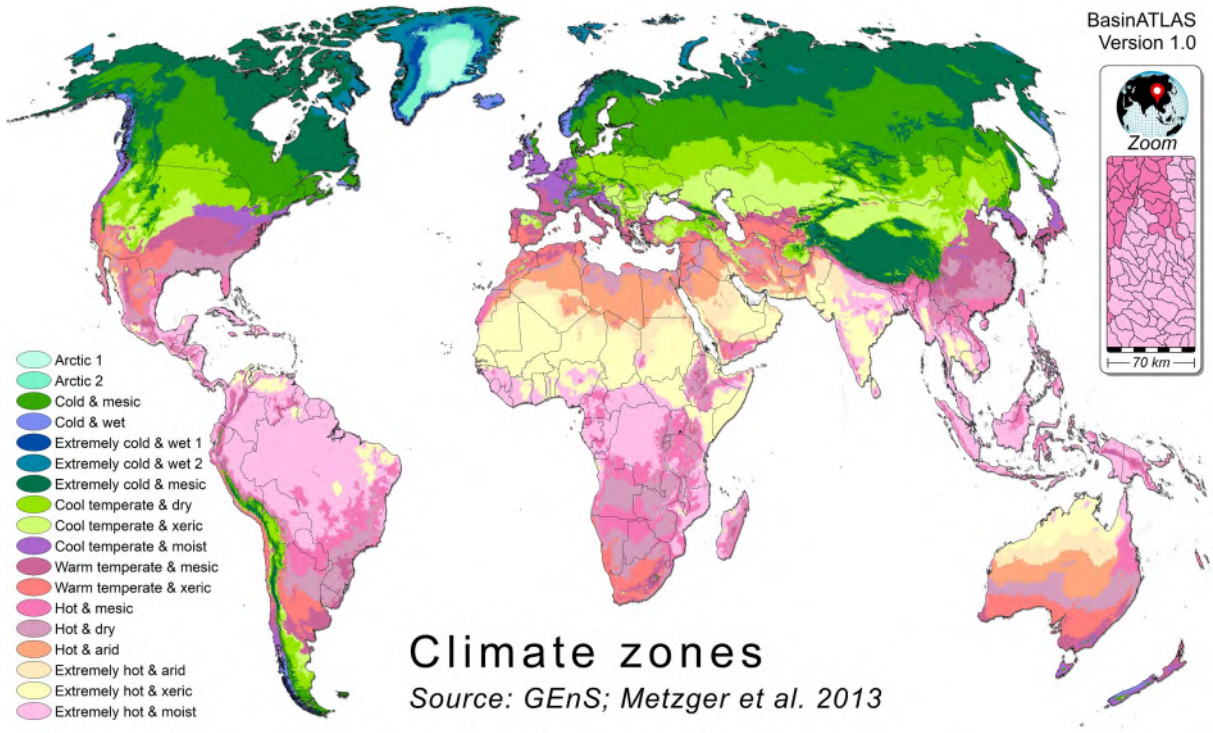
Citation: Metzger et al. 2013 ***Native format:*** Polygons ***Units:*** classes (18)

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {mj} spatial majority

Existing suffixes {xoo}: smj



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

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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)

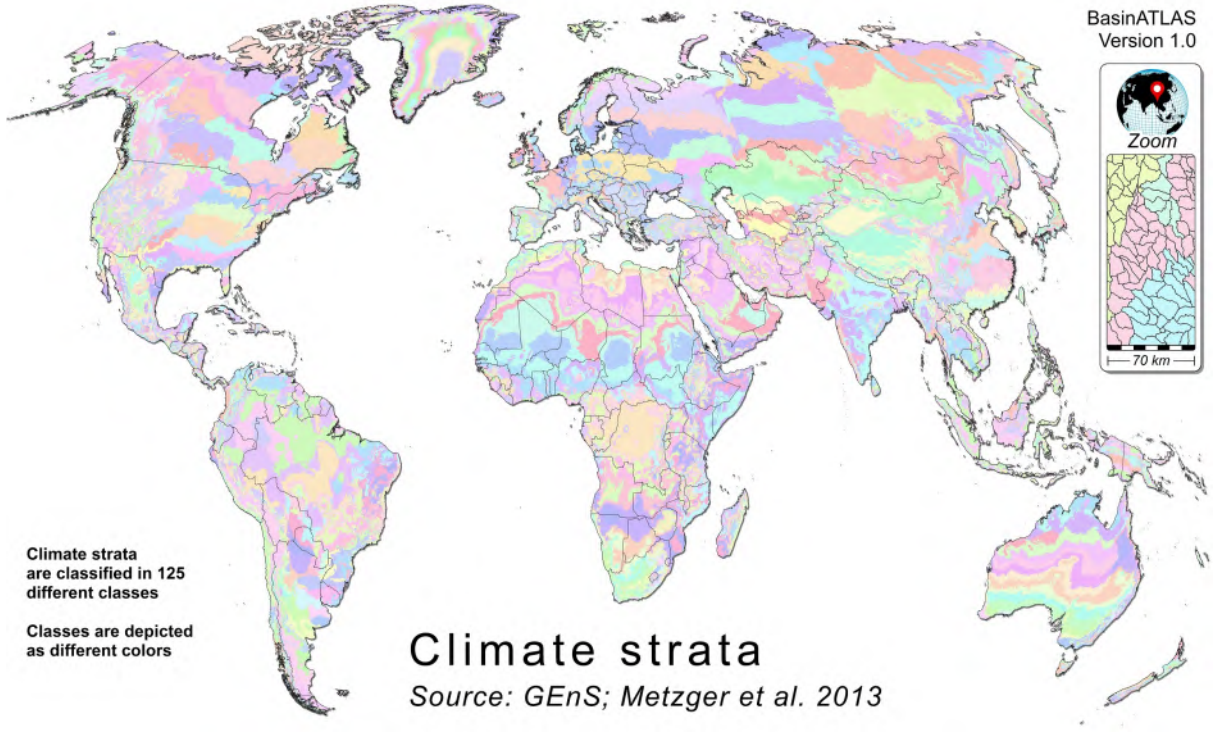
Citation: Metzger et al. 2013 ***Native format:*** Polygons ***Units:*** classes (125)

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {mj} spatial majority

Existing suffixes {xoo}: smj



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

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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

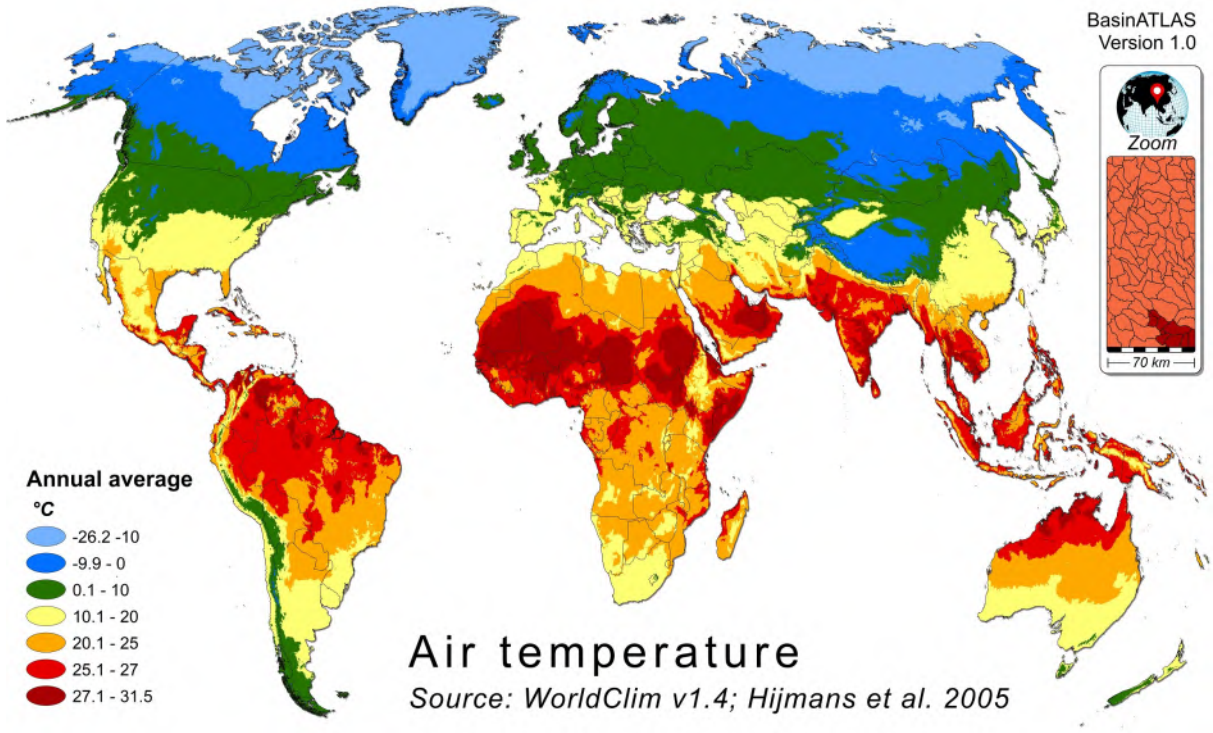
Citation: Hijmans et al. 2005 ***Native format:*** 30 arc-second grid ***Units:*** degrees Celsius (x10)

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: syr | smn | smx | s01-s12 | 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

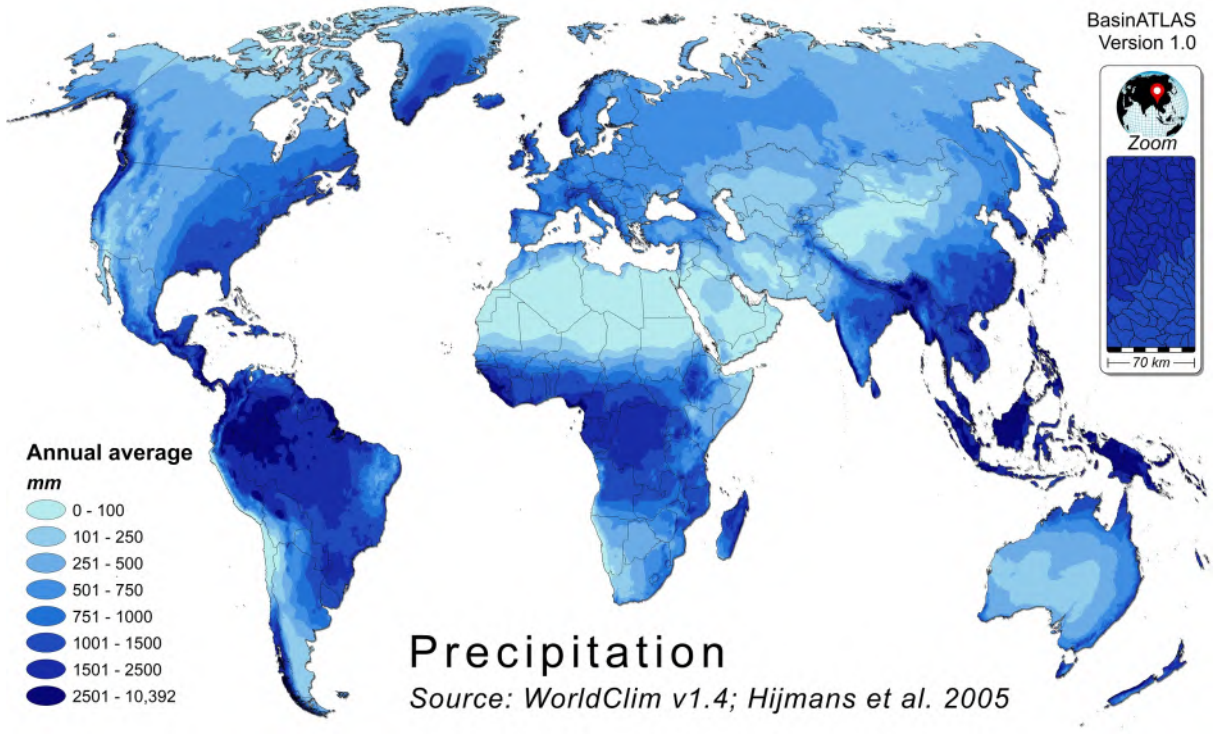
Citation: Hijmans et al. 2005 ***Native format:*** 30 arc-second grid ***Units:*** millimeters

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: syr | s01-s12 | 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

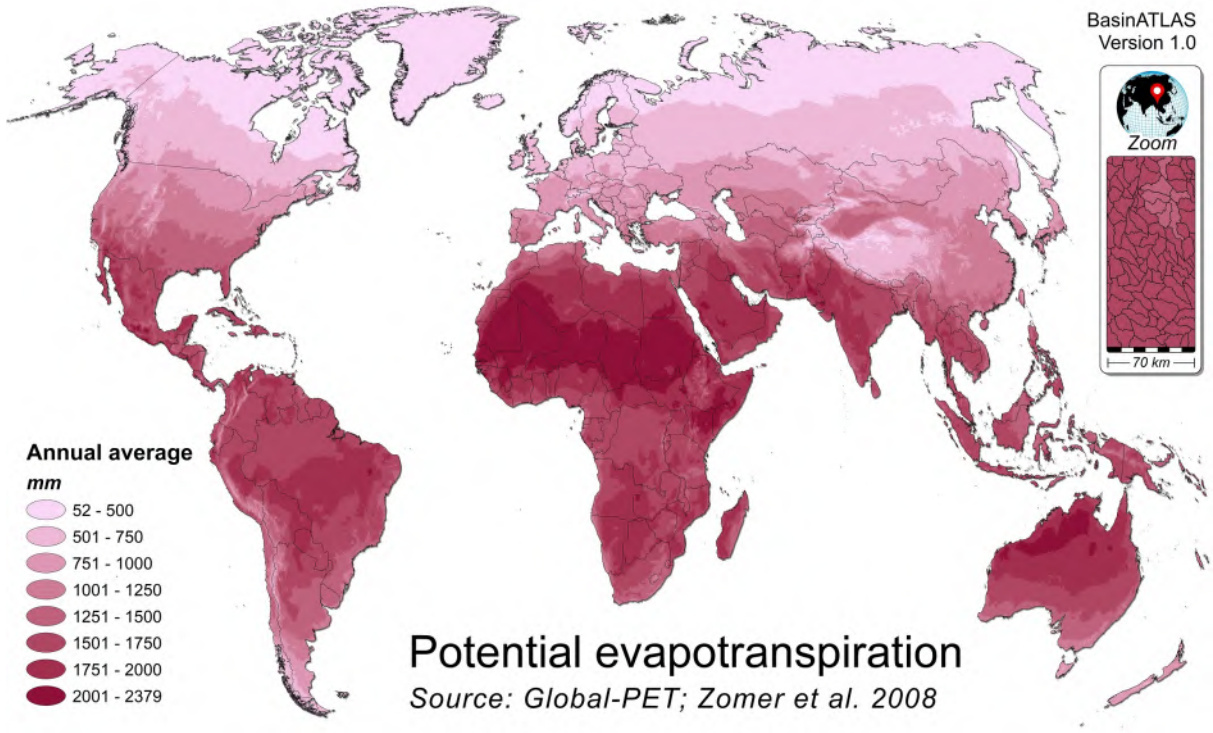
Citation: Zomer et al. 2008 ***Native format:*** 30 arc-second grid ***Units:*** millimeters

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: syr | s01-s12 | 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

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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

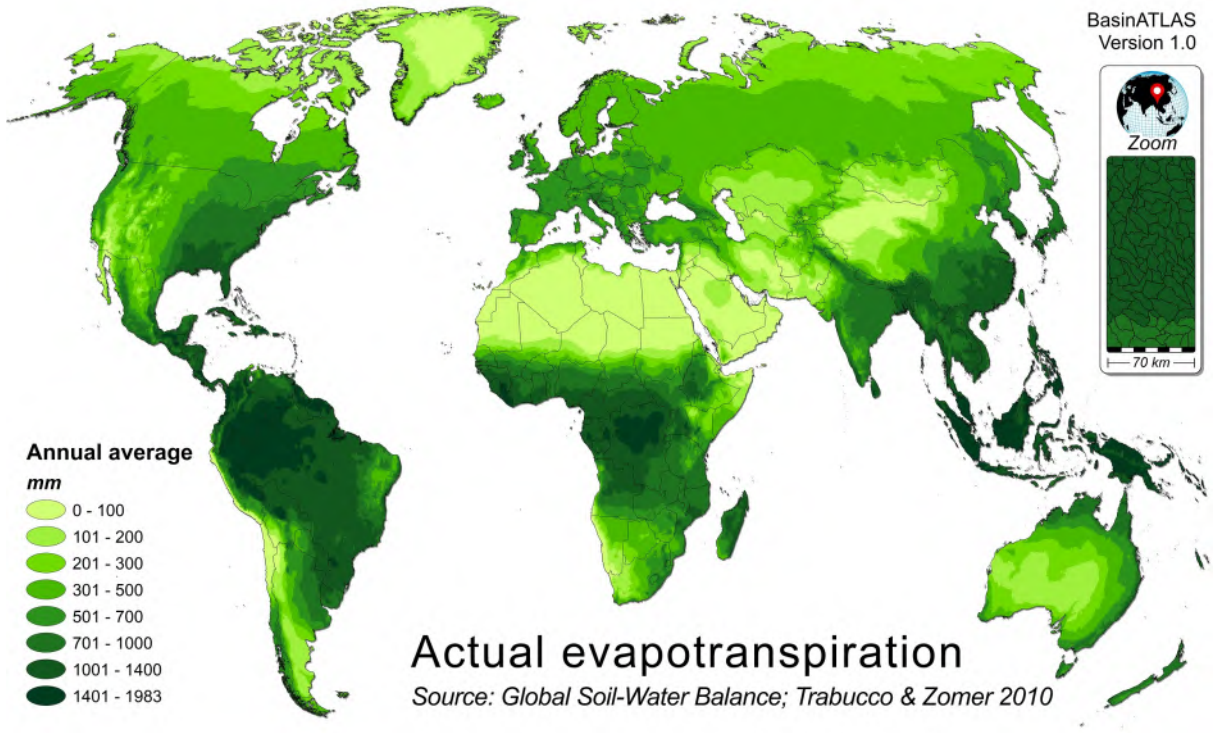
Citation: Trabucco & Zomer 2010 ***Native format:*** 30 arc-second grid ***Units:*** millimeters

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: syr | s01-s12 | 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

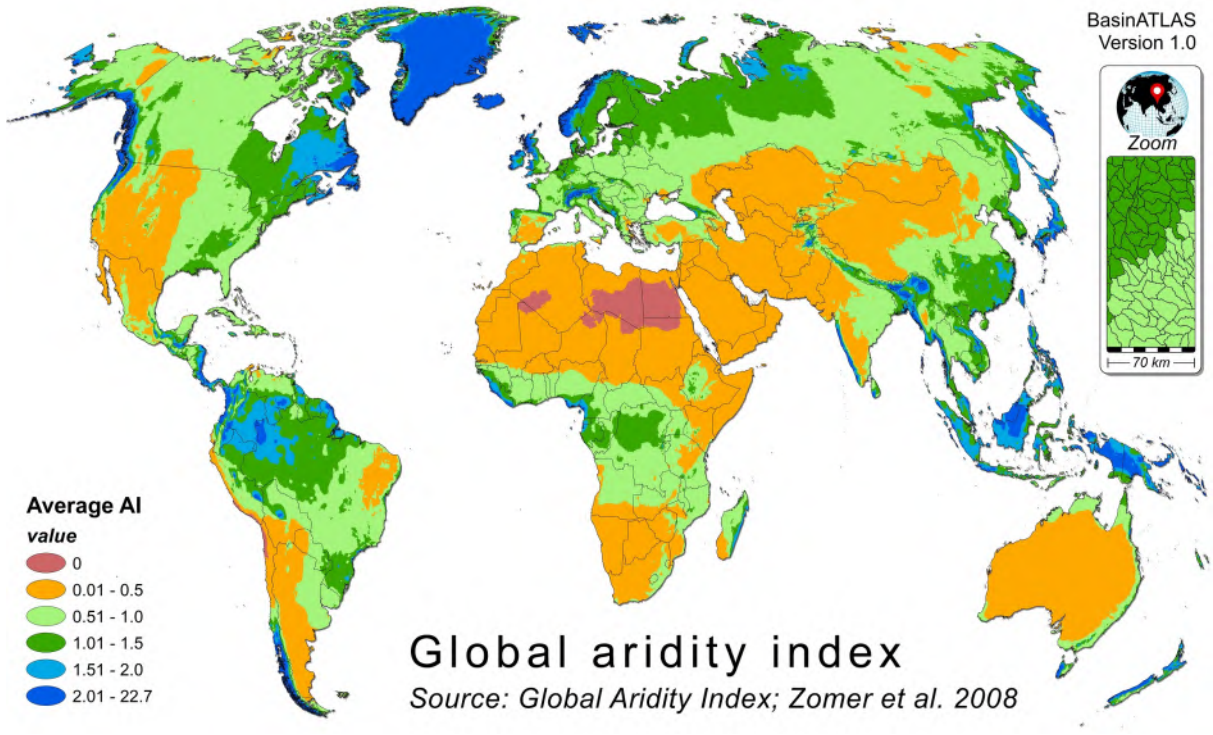
Citation: Zomer et al. 2008 ***Native format:*** 30 arc-second grid ***Units:*** index value (x100)

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav | 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

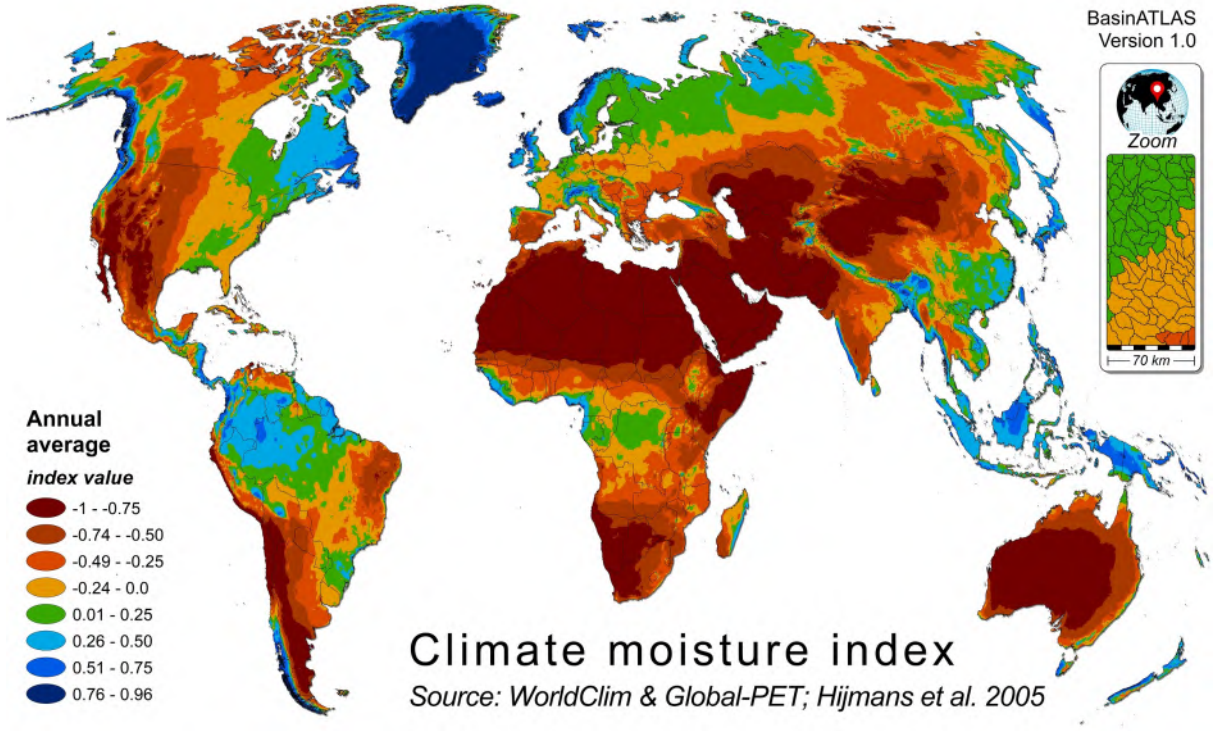
Citation: Hijmans et al. 2005 ***Native format:*** 30 arc-second grids ***Units:*** index value (x100)

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: syr | s01-s12 | 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

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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)

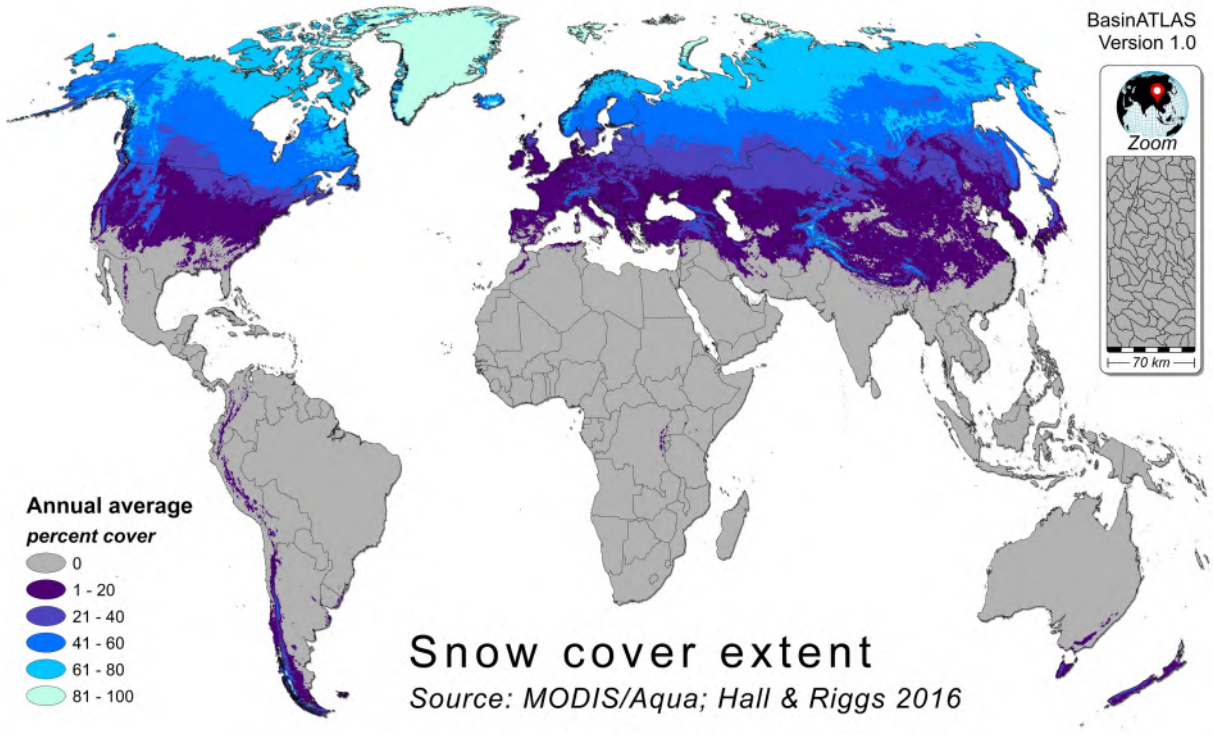
Citation: Hall & Riggs 2016 ***Native format:*** 15 arc-second grid ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: syr | smx | s01-s12 | 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

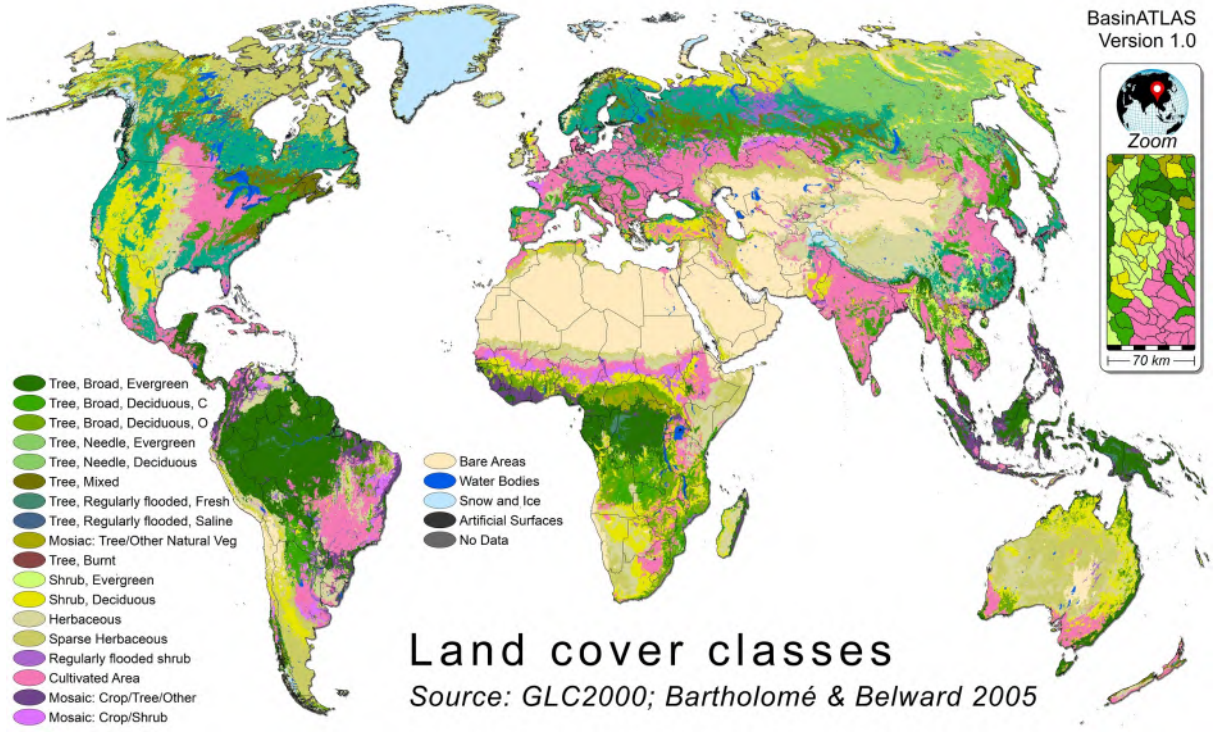
Citation: Bartholomé & Belward 2005 ***Native format:*** 30 arc-second grid ***Units:*** classes (22)

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {mj} spatial majority

Existing suffixes {xoo}: smj



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

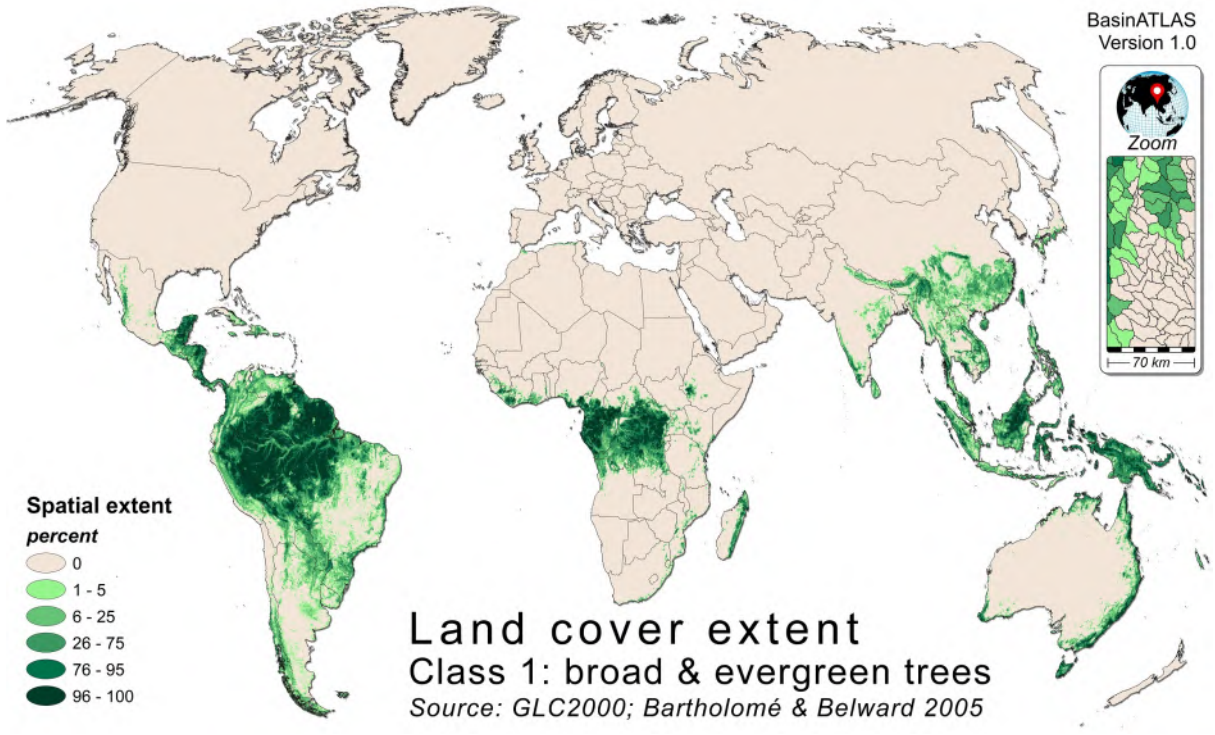
Citation: Bartholomé & Belward 2005 ***Native format:*** 30 arc-second grid ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: s01-s22 | 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

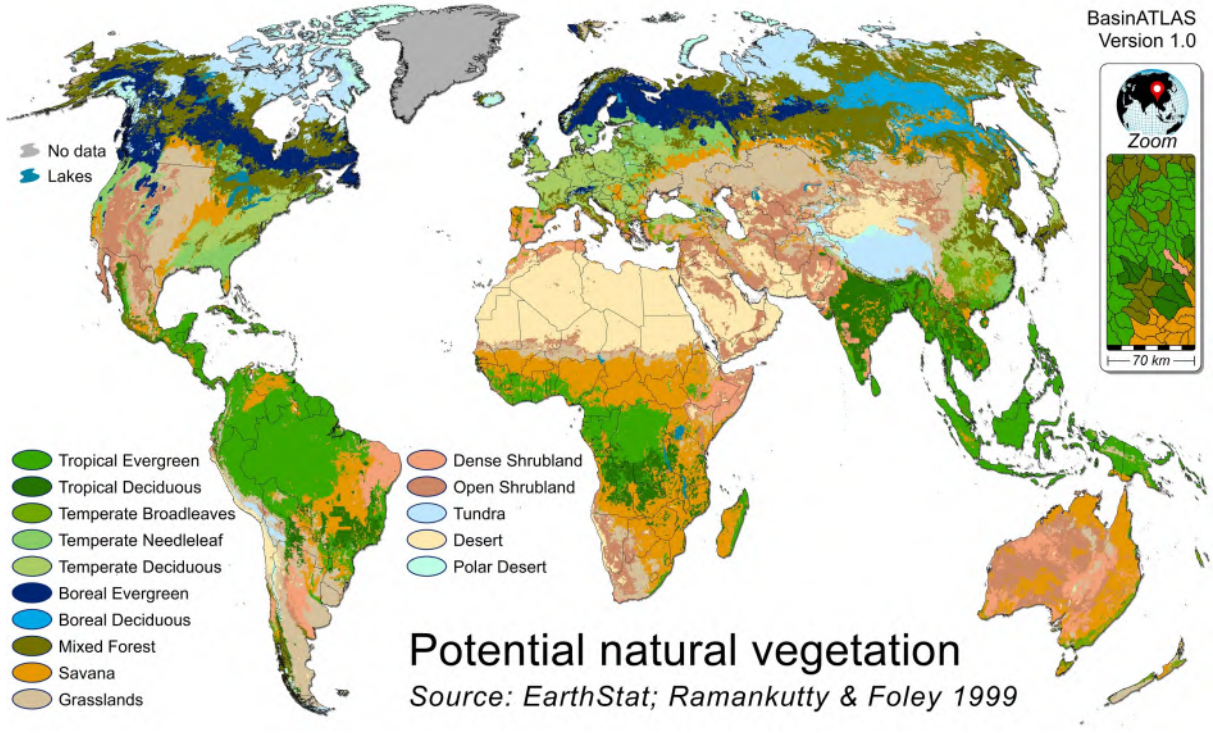
Citation: Ramankutty & Foley 1999 ***Native format:*** 5 arc-min grid ***Units:*** classes (15)

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {mj} spatial majority

Existing suffixes {xoo}: smj



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

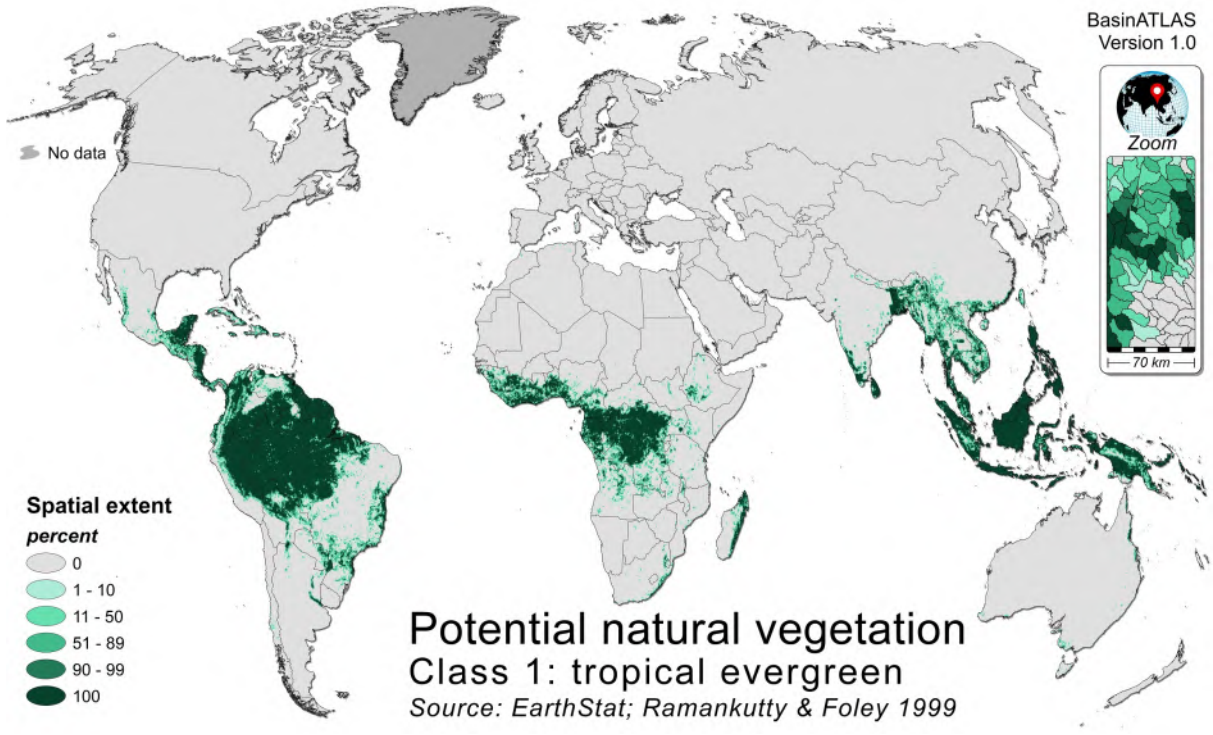
Citation: Ramankutty & Foley 1999 ***Native format:*** 5 arc-min grid ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: s01-s15 | 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)

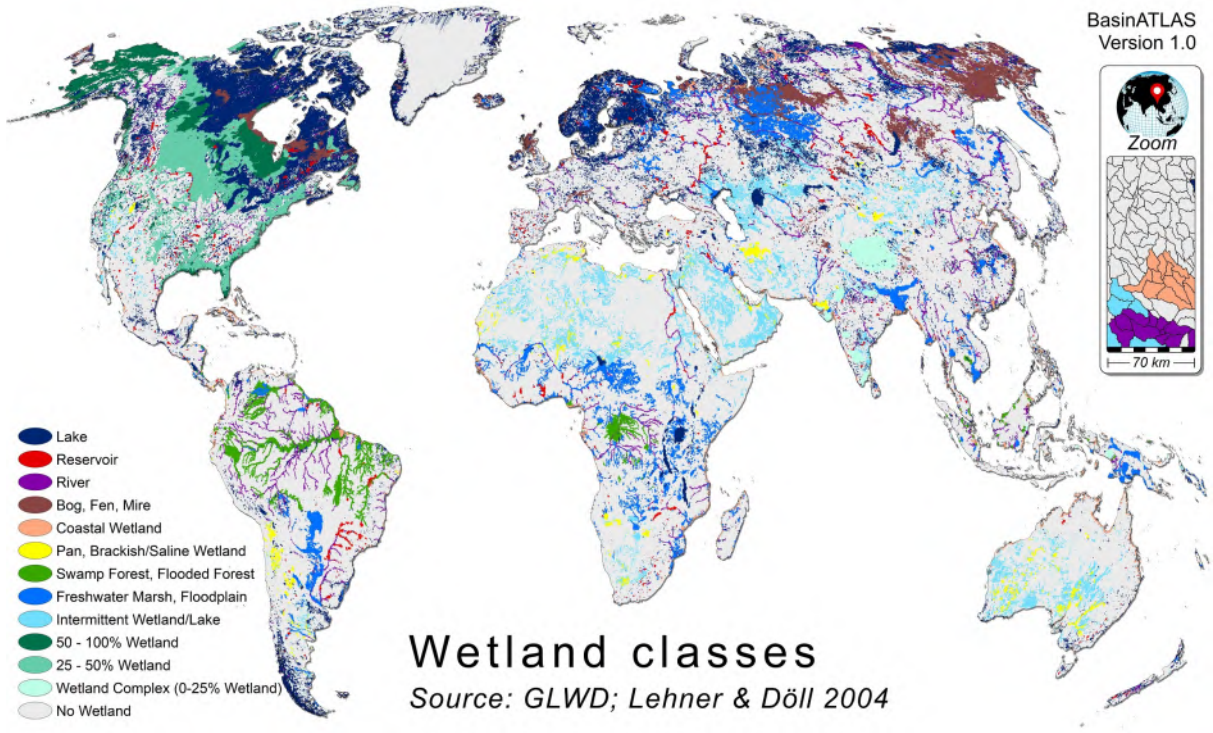
Citation: Lehner & Döll 2004 ***Native format:*** Polygons ***Units:*** classes (12)

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {mj} spatial majority

Existing suffixes {xoo}: smj



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)

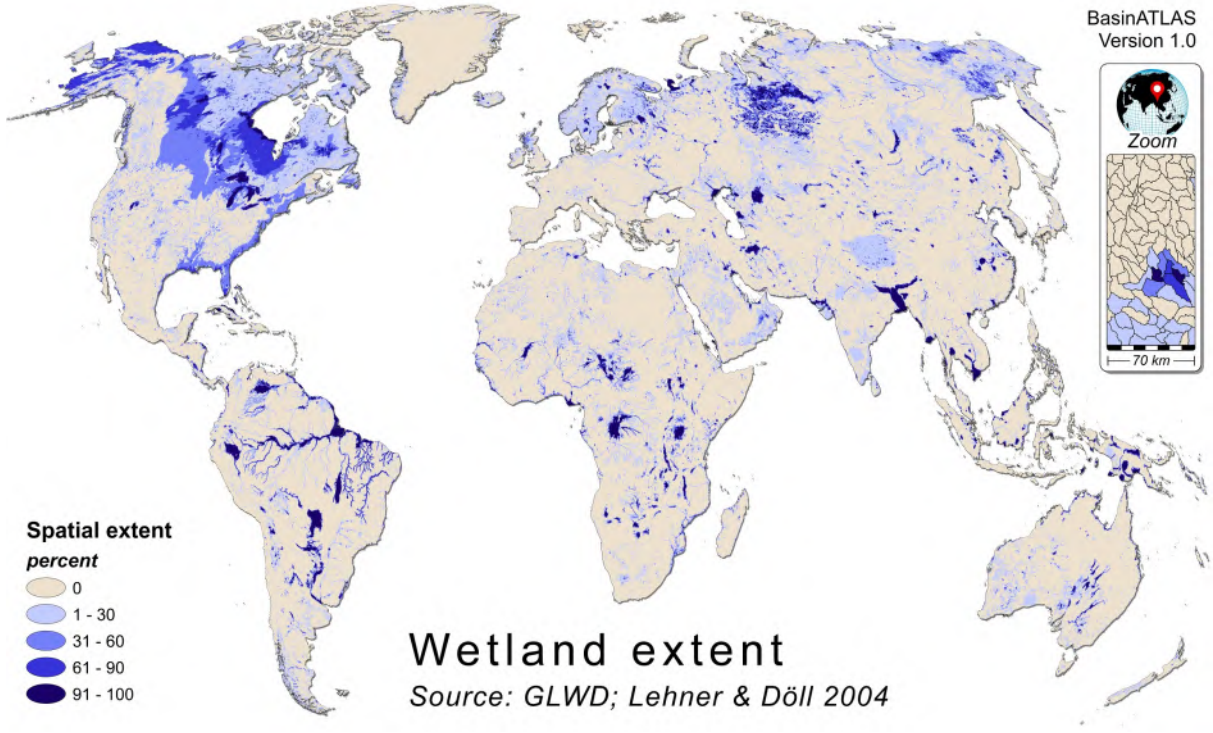
Citation: Lehner & Döll 2004 ***Native format:*** Polygons ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: s01-s09 | sg1 | sg2 | 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

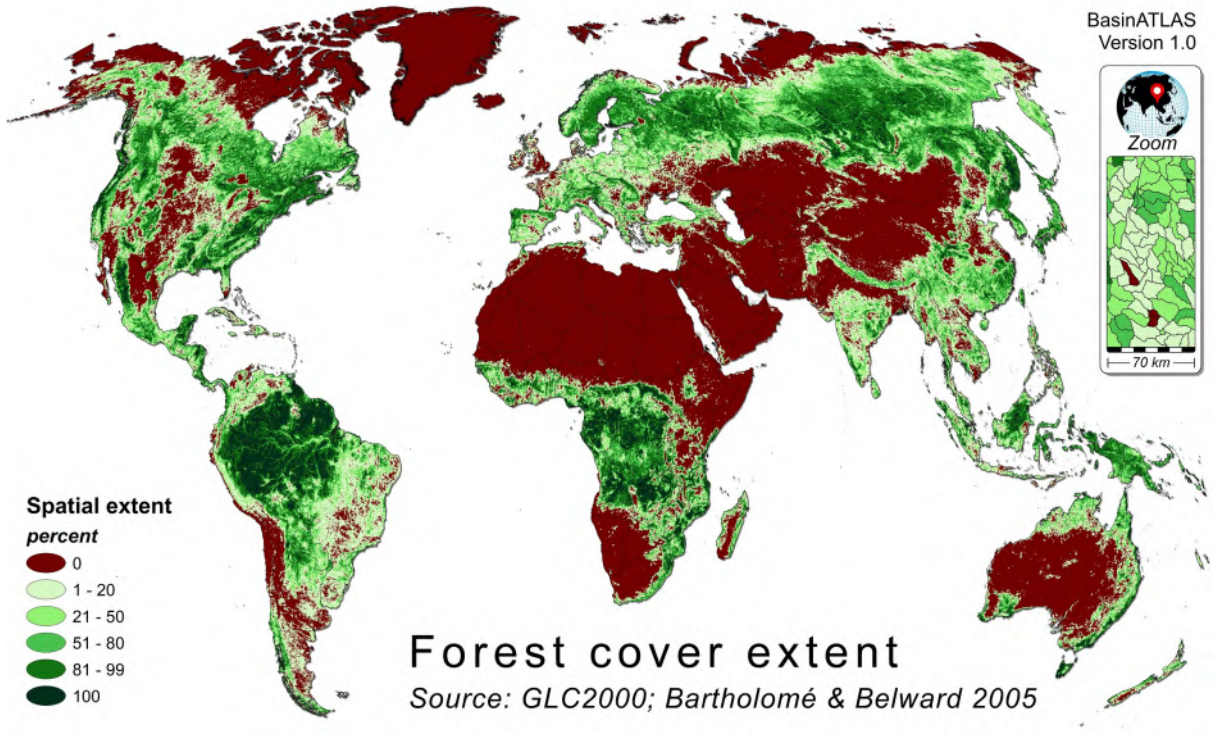
Citation: Bartholomé & Belward 2005 ***Native format:*** 30 arc-second grid ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: sse | 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

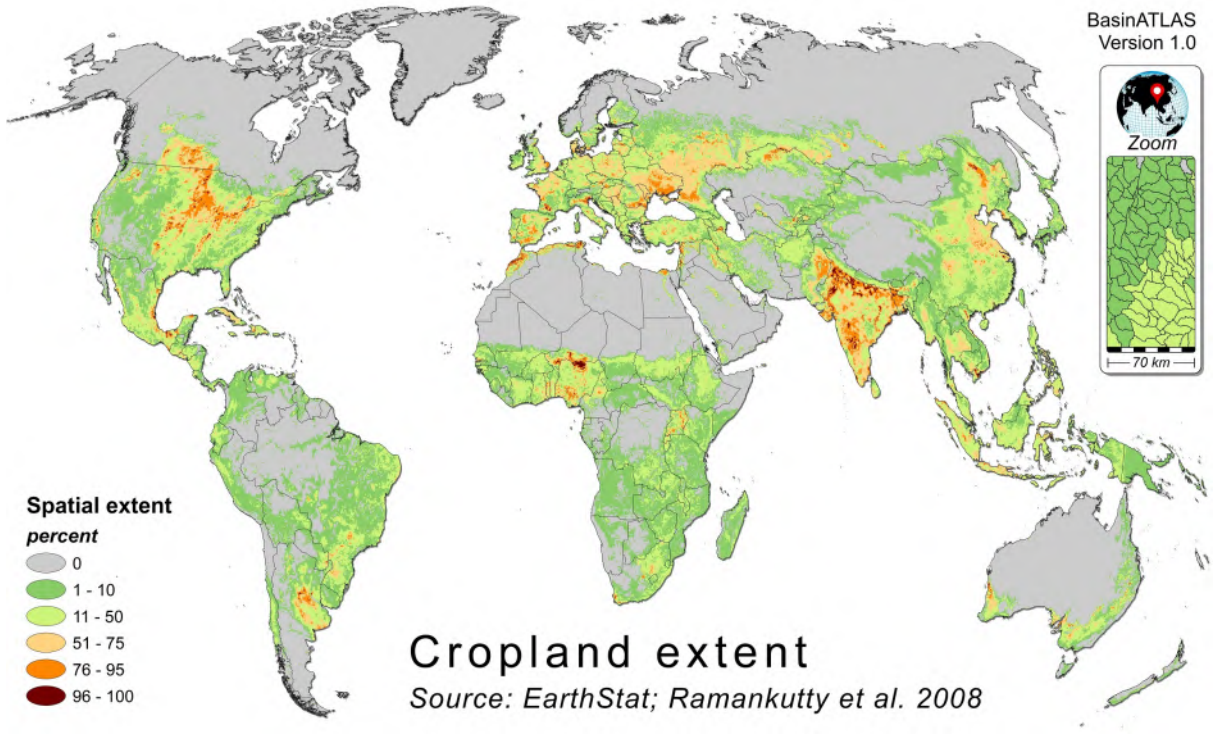
Citation: Ramankutty et al. 2008 ***Native format:*** 5 arc-min grid ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: sse | 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/

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Additional information

None

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

Attribute Pasture Extent

Source data EarthStat

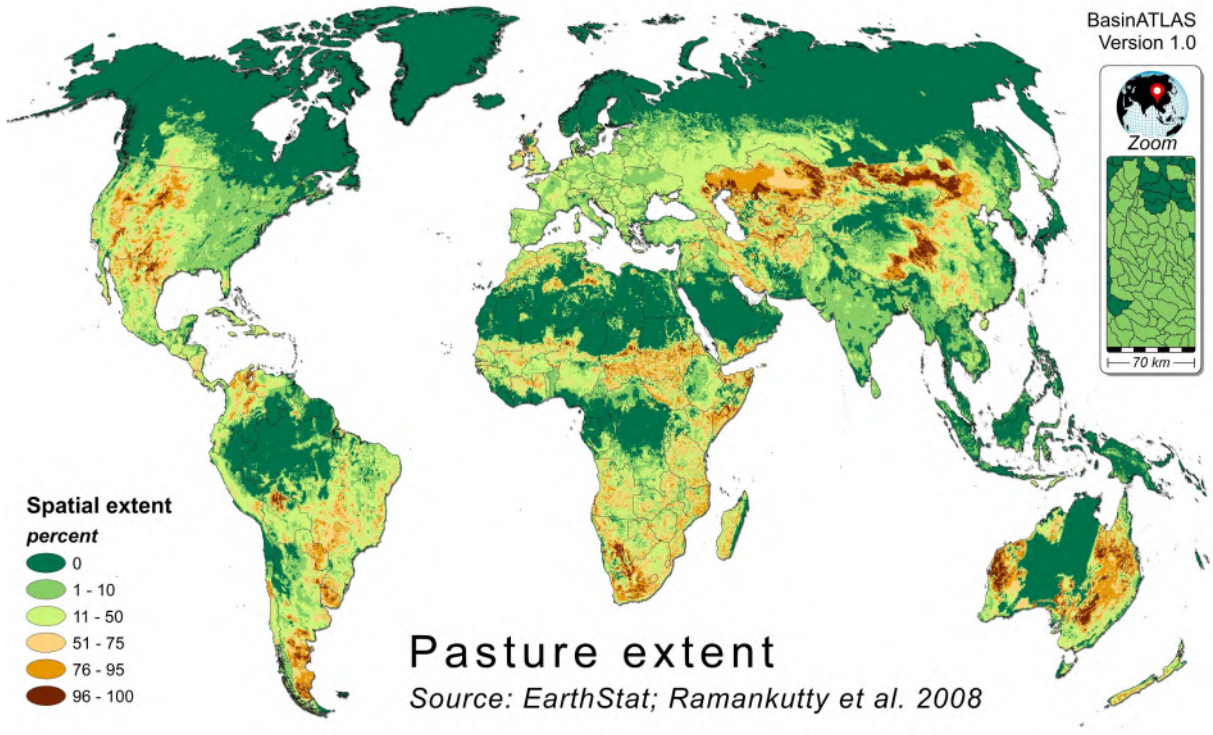
Citation: Ramankutty et al. 2008 ***Native format:*** 5 arc-min grid ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: sse | 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

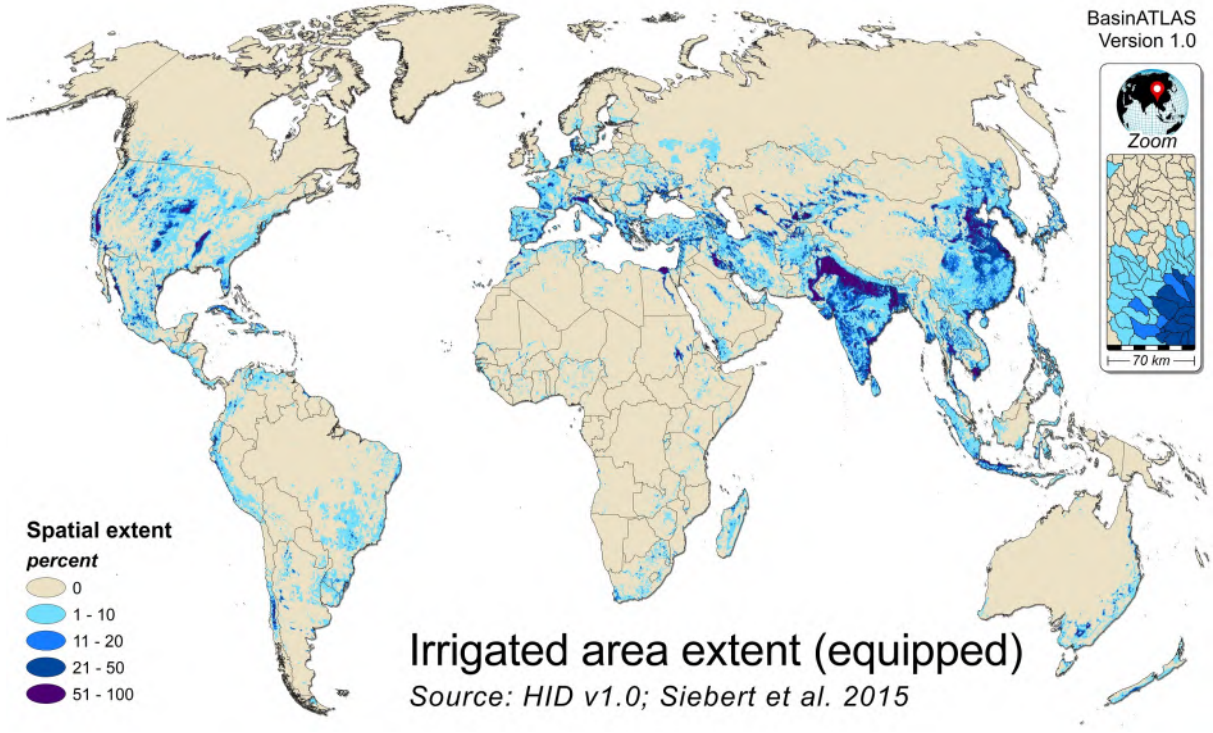
Citation: Siebert et al. 2015 ***Native format:*** 5 arc-min grid ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: sse | 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)

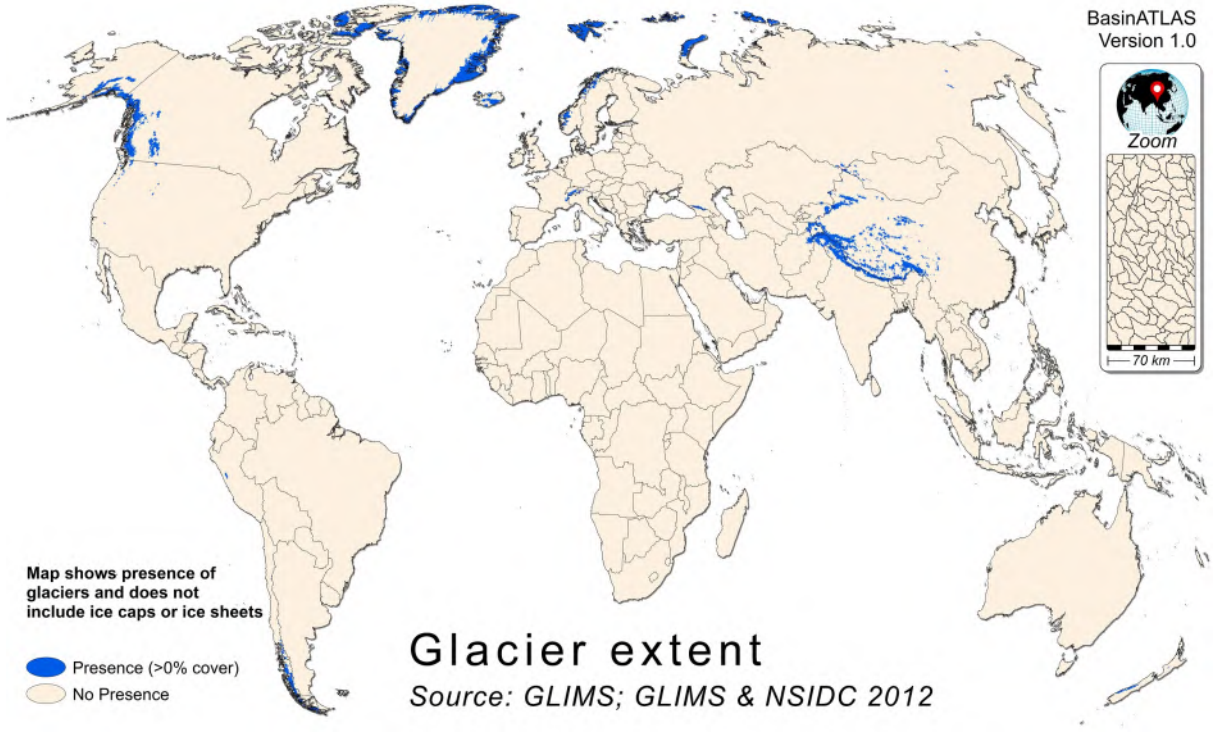
Citation: GLIMS & NSIDC 2012 ***Native format:*** Polygons ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: sse | 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)

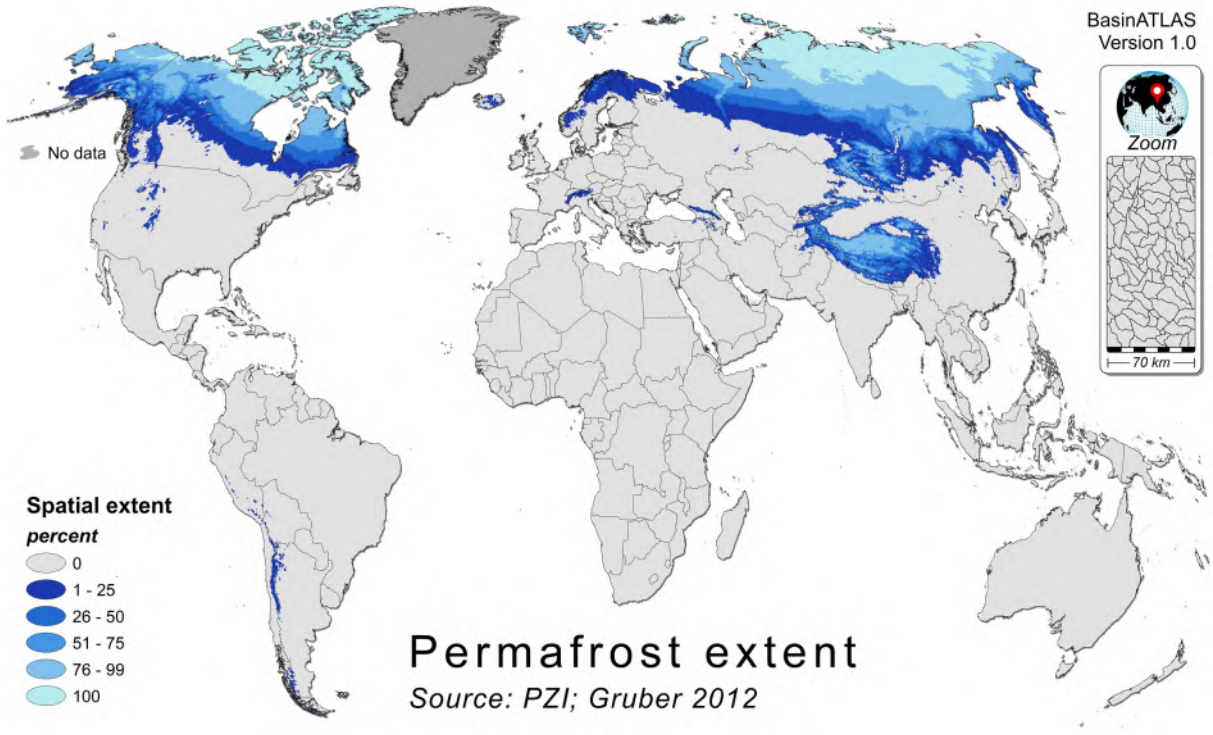
Citation: Gruber 2012 ***Native format:*** 30 arc-second grid ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: sse | 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)

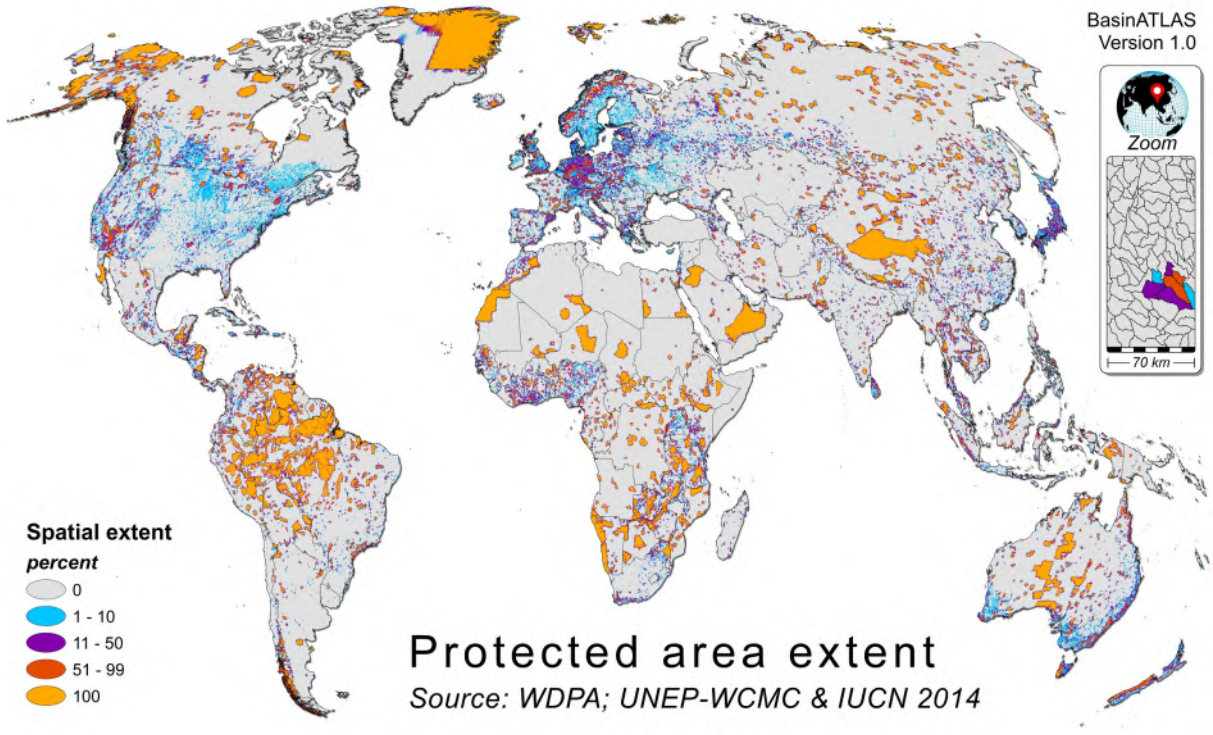
Citation: IUCN & UNEP-WCMC 2014 ***Native format:*** Polygons & points ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: sse | 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)

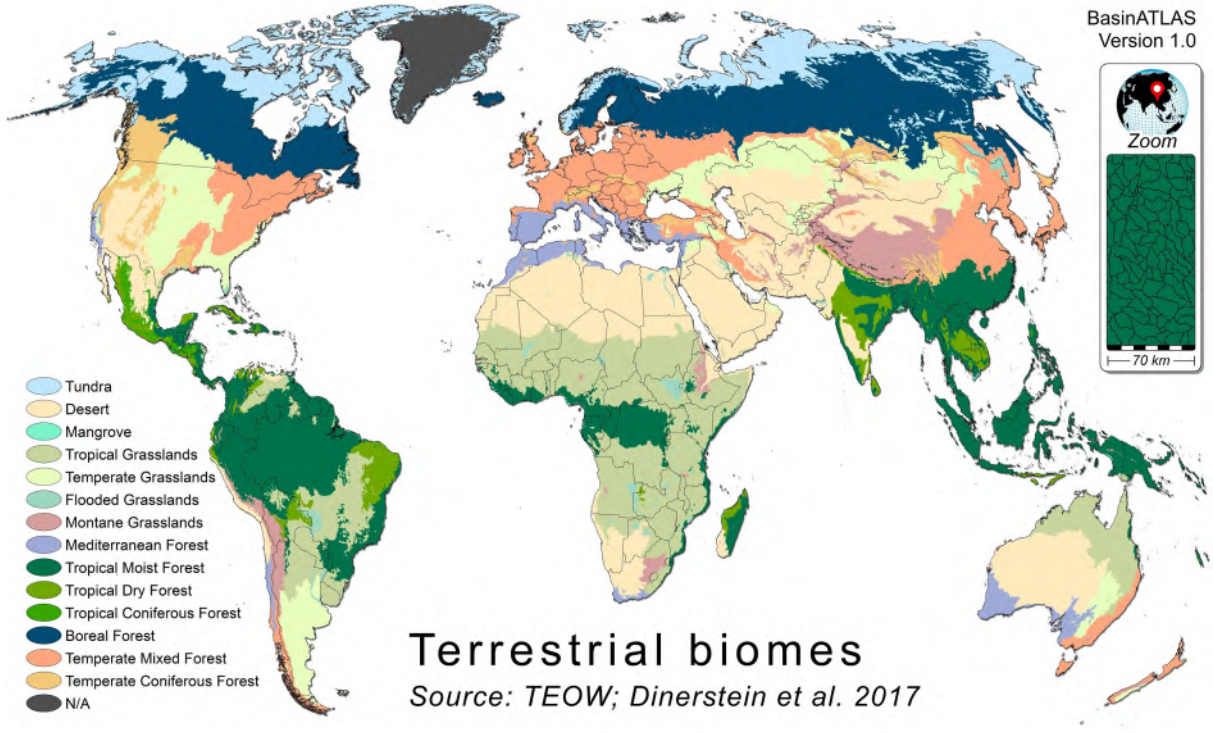
Citation: Dinerstein et al. 2017 ***Native format:*** Polygons ***Units:*** classes (14)

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {mj} spatial majority

Existing suffixes {xoo}: smj



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)

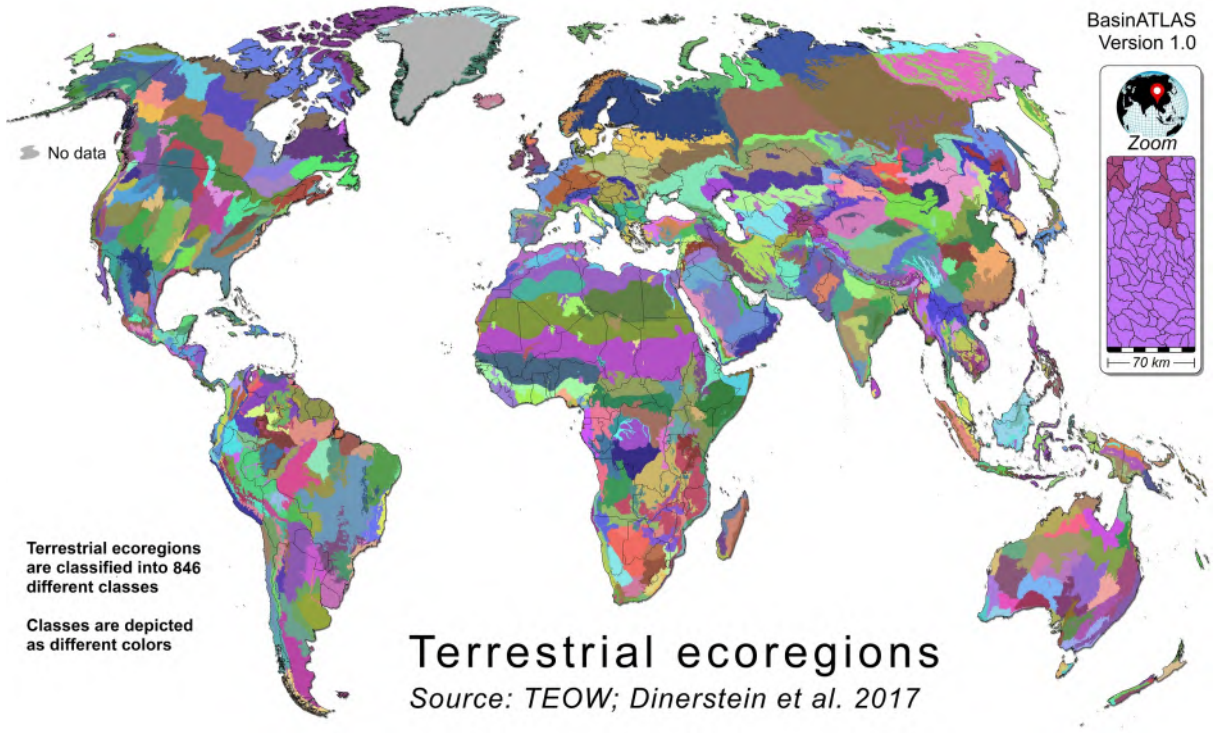
Citation: Dinerstein et al. 2017 ***Native format:*** Polygons ***Units:*** classes (846)

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {mj} spatial majority

Existing suffixes {xoo}: smj



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)

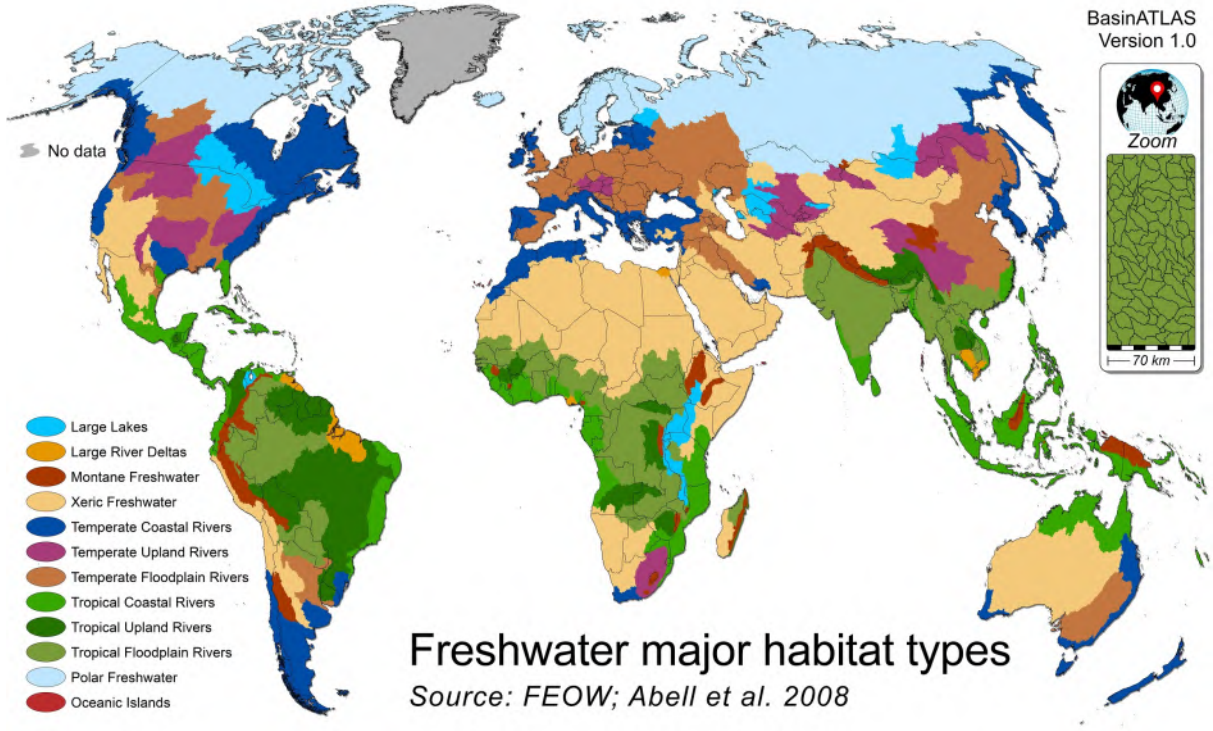
Citation: Abell et al. 2008 ***Native format:*** Polygons ***Units:*** classes (13)

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {mj} spatial majority

Existing suffixes {xoo}: smj



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)

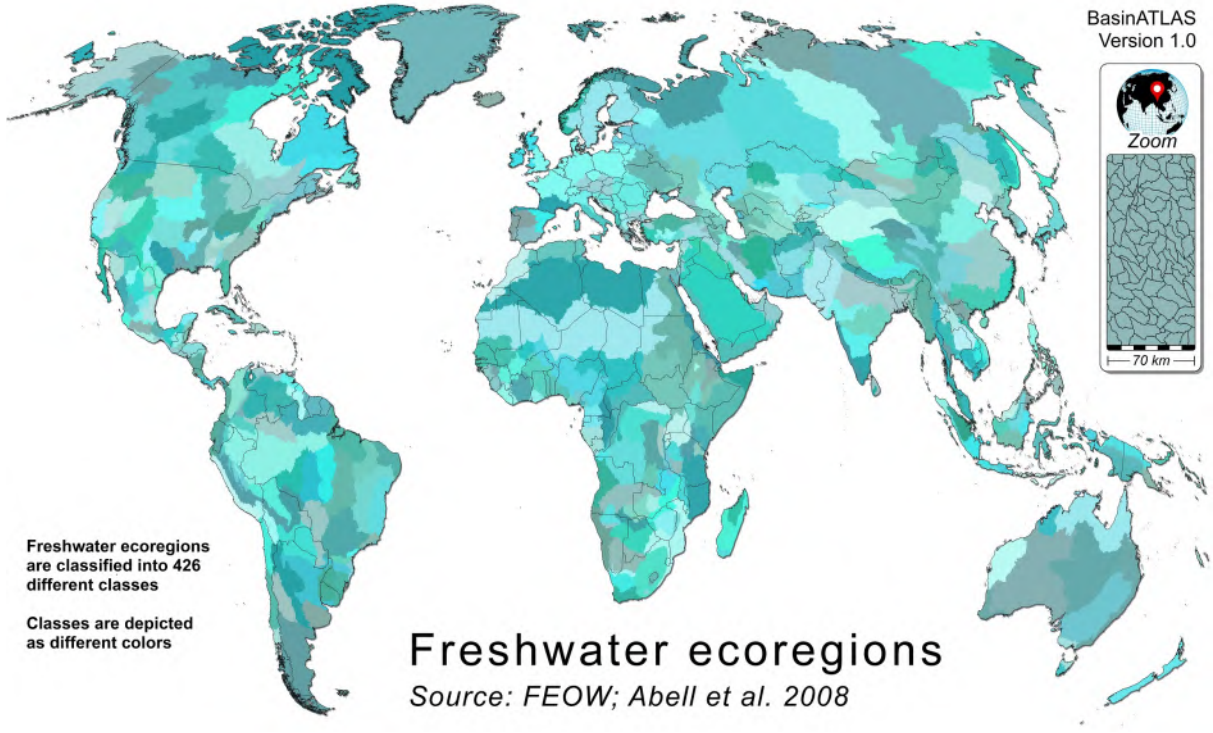
Citation: Abell et al. 2008 ***Native format:*** Polygons ***Units:*** classes (426)

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {mj} spatial majority

Existing suffixes {xoo}: smj



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

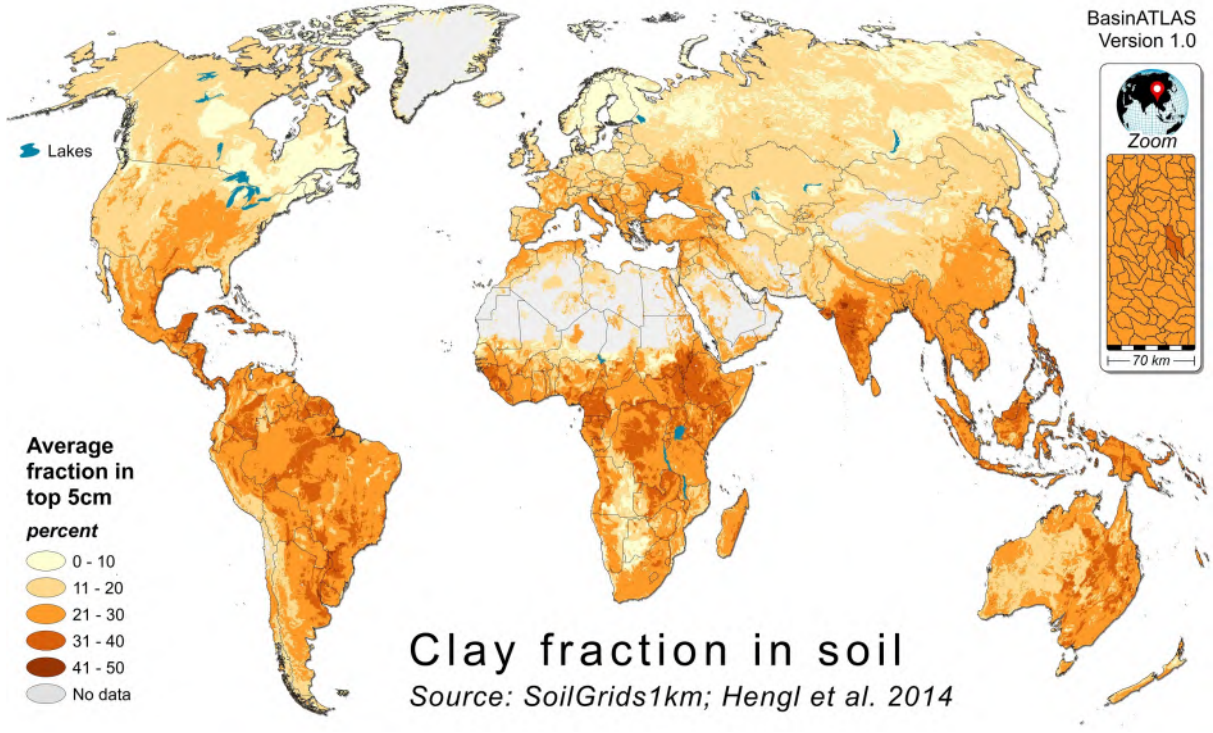
Citation: Hengl et al. 2014 ***Native format:*** 30 arc-second grid ***Units:*** percent

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav | 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

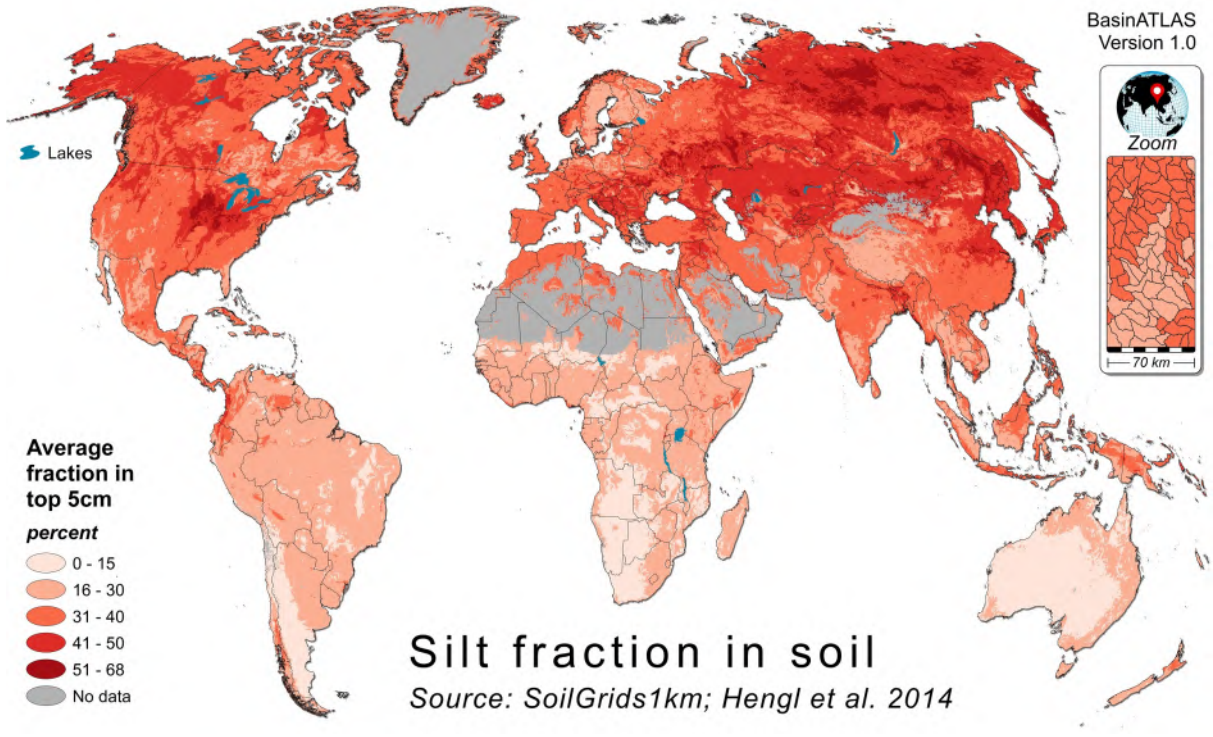
Citation: Hengl et al. 2014 ***Native format:*** 30 arc-second grid ***Units:*** percent

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav | 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

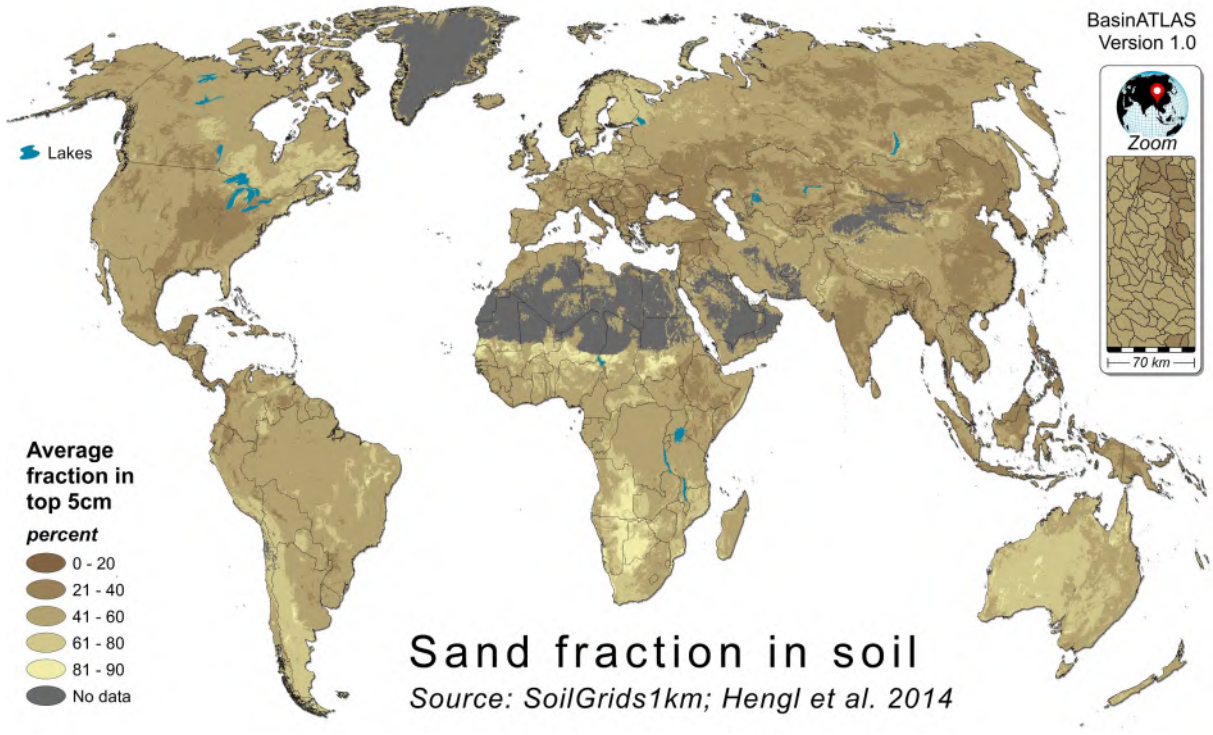
Citation: Hengl et al. 2014 ***Native format:*** 30 arc-second grid ***Units:*** percent

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav | 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

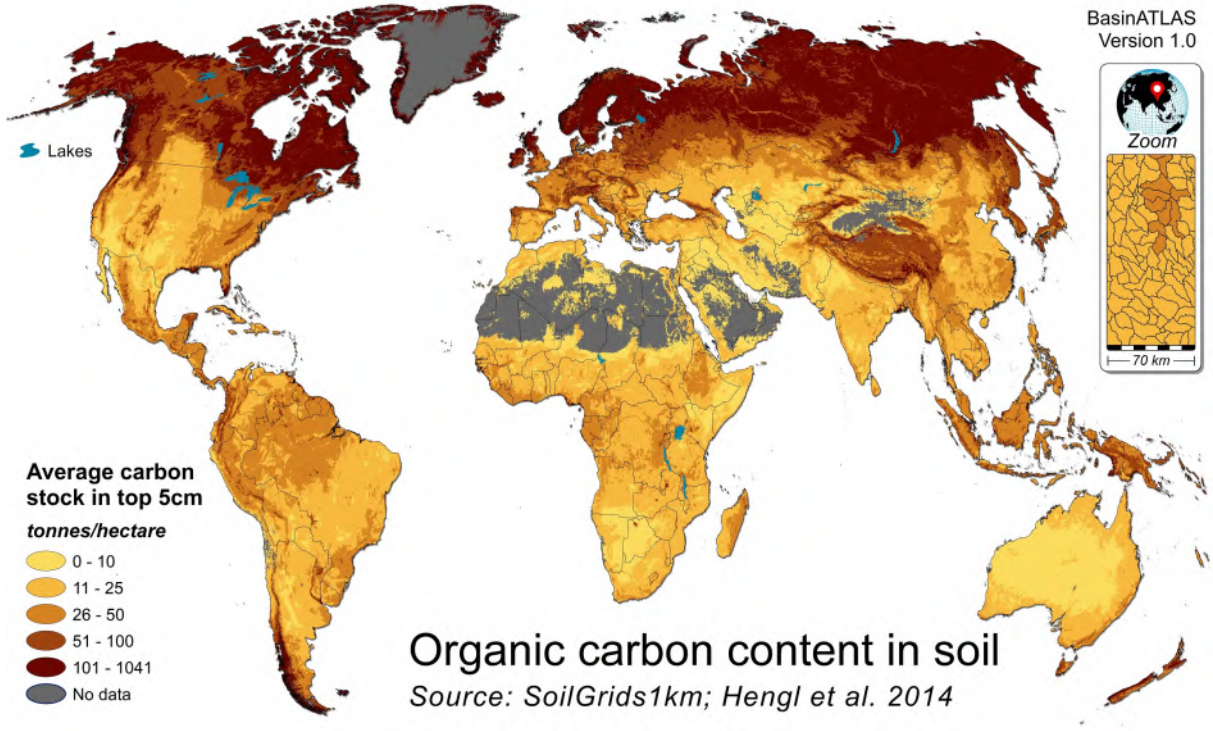
Citation: Hengl et al. 2014 ***Native format:*** 30 arc-second grid ***Units:*** tonnes/hectare

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav | 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

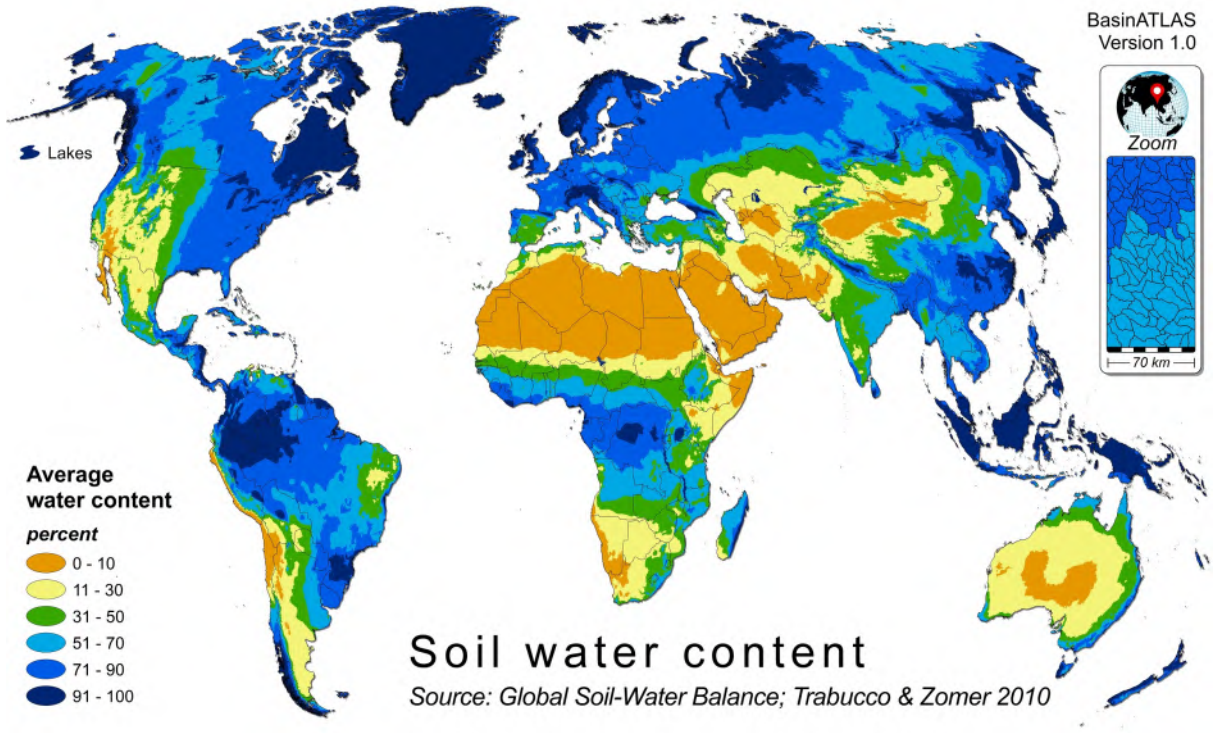
Citation: Trabucco & Zomer 2010 ***Native format:*** 30 arc-second grid ***Units:*** percent

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: syr | s01-s12 | 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)

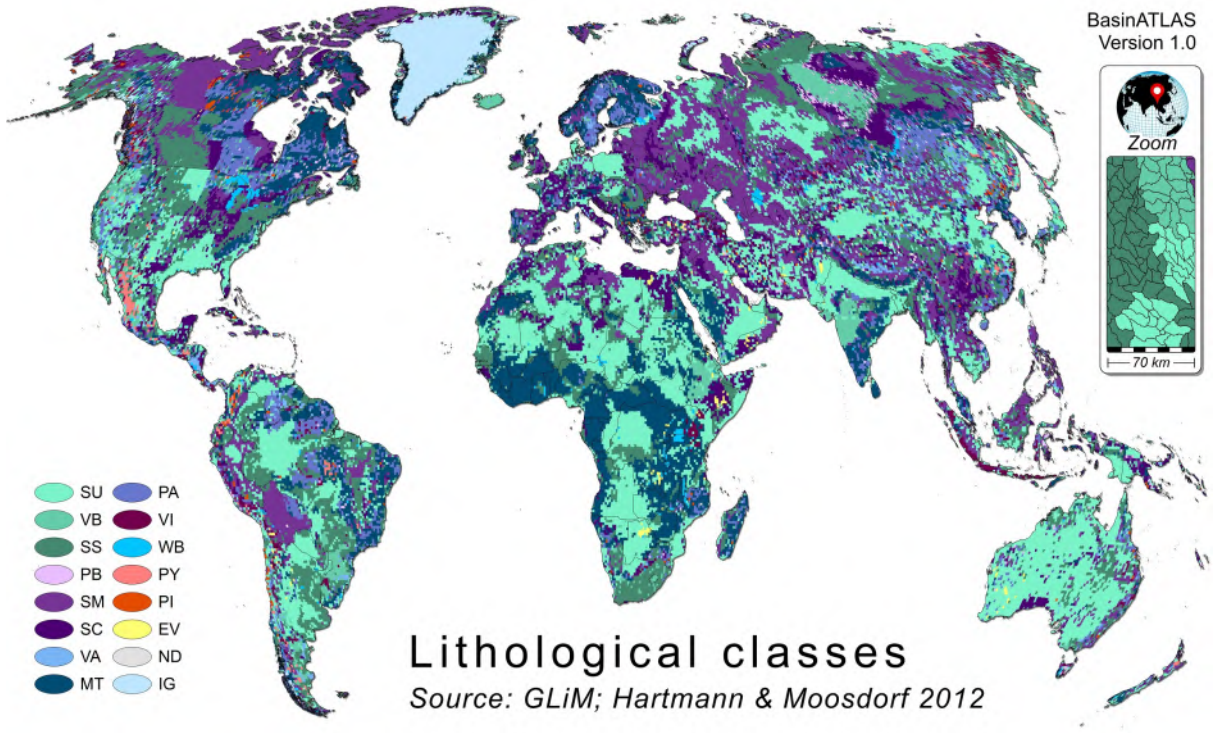
Citation: Hartmann & Moosdorf 2012 ***Native format:*** 30 arc-minute grid ***Units:*** classes (16)

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {mj} spatial majority

Existing suffixes {xoo}: smj



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

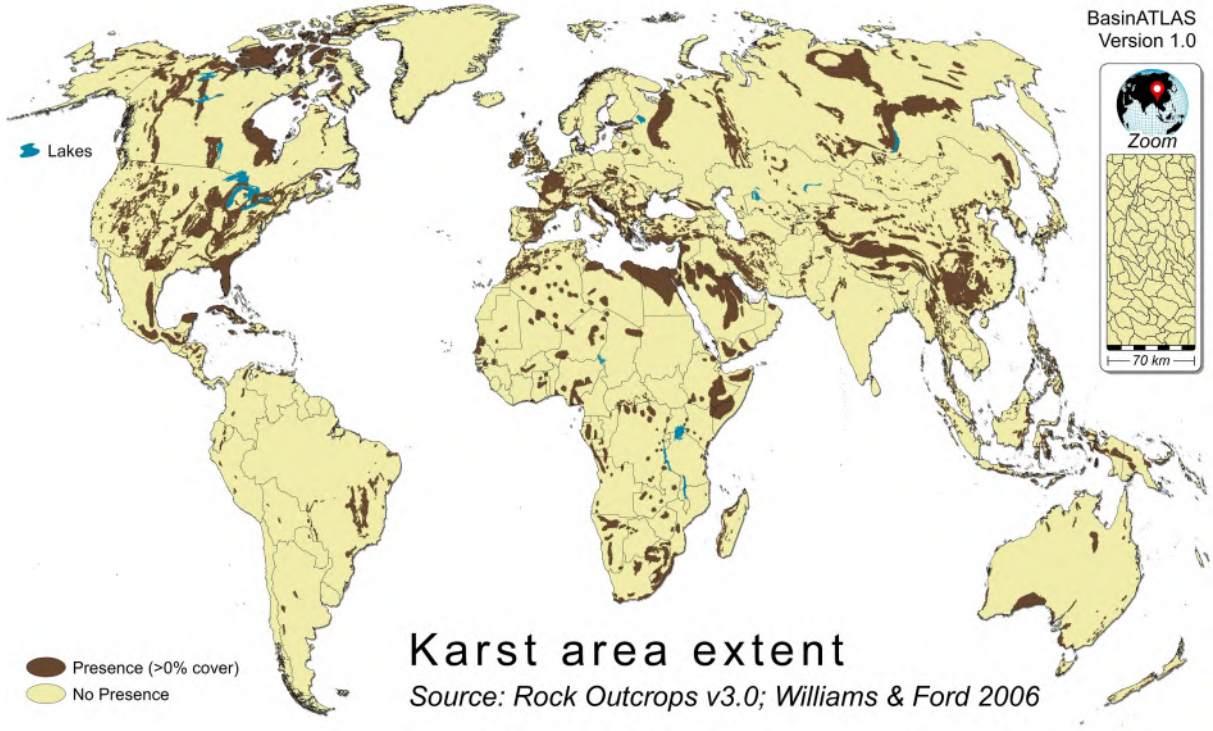
Citation: Williams & Ford 2006 ***Native format:*** Polygons ***Units:*** percent cover

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: sse | 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

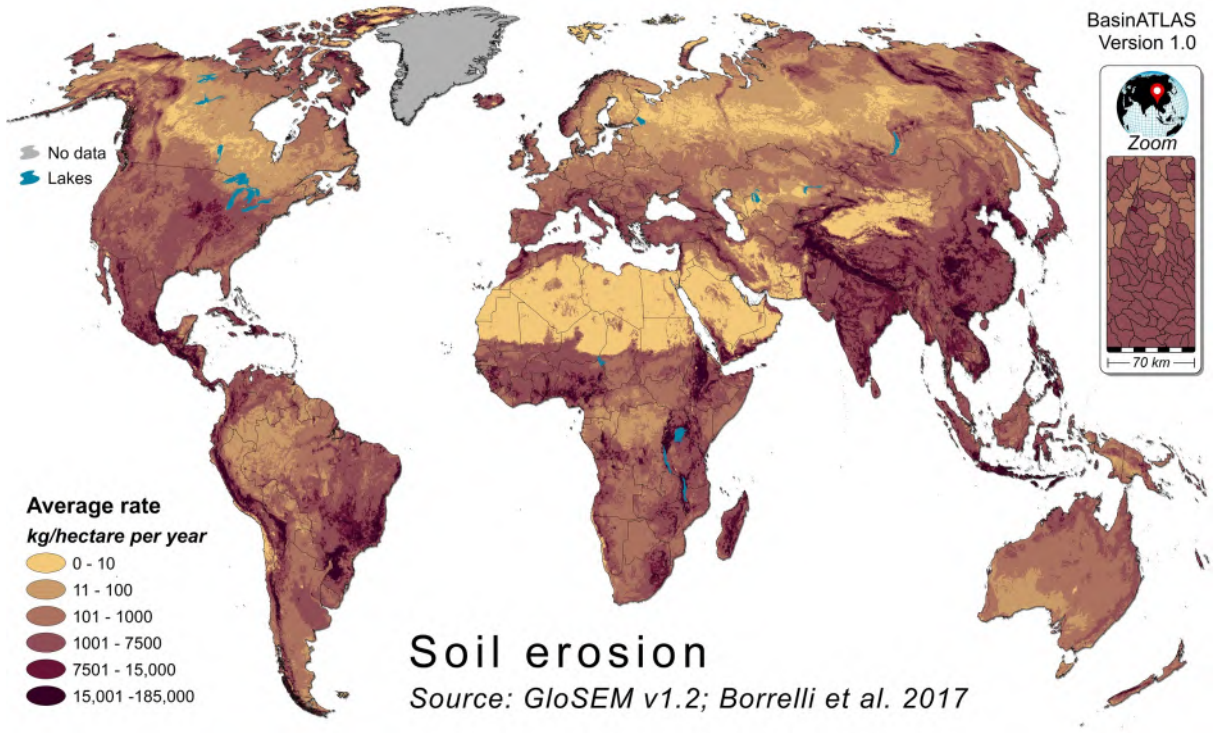
Citation: Borrelli et al. 2017 ***Native format:*** 250-m grid ***Units:*** kg/hectare per year

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav | 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

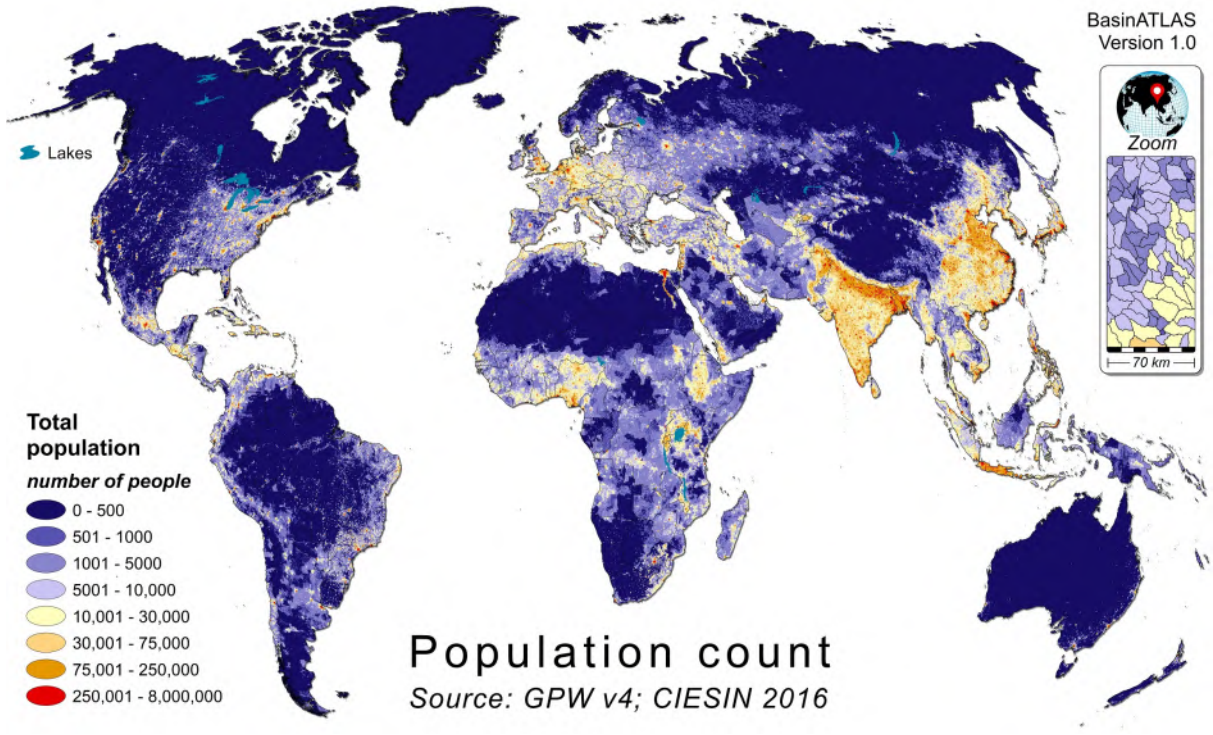
Citation: CIESIN 2016 ***Native format:*** 30 arc-second grid ***Units:*** count (thousands)

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {su} sum

Existing suffixes {xoo}: ssu | 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

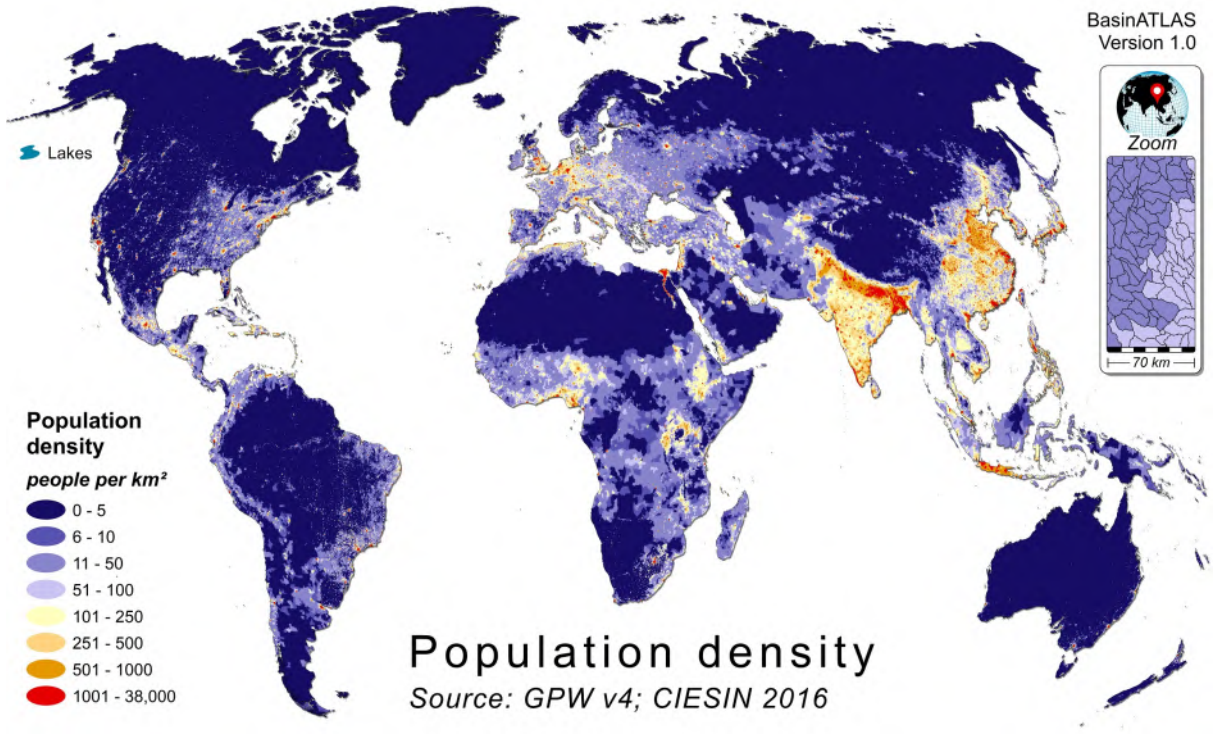
Citation: CIESIN 2016 ***Native format:*** 30 arc-second grid ***Units:*** people per km²

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav | 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

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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)

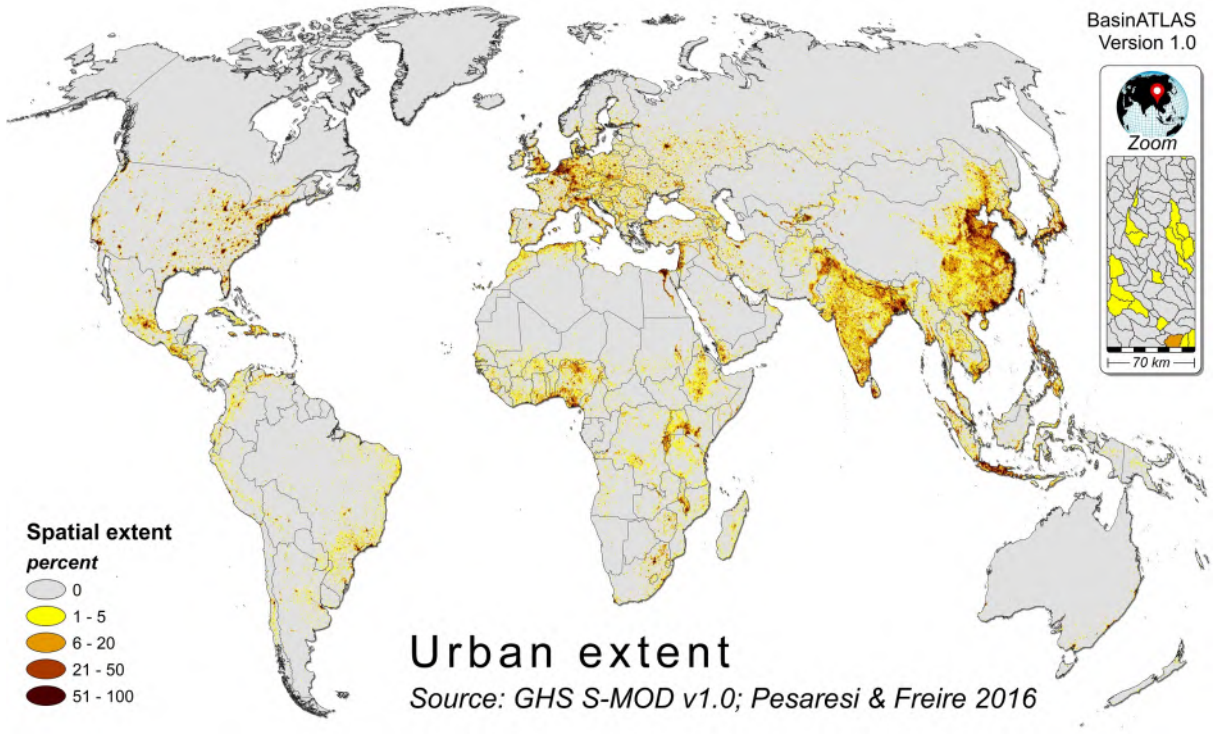
Citation: Pesaresi & Freire 2016 ***Native format:*** 1-km grid ***Units:*** percent cover

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

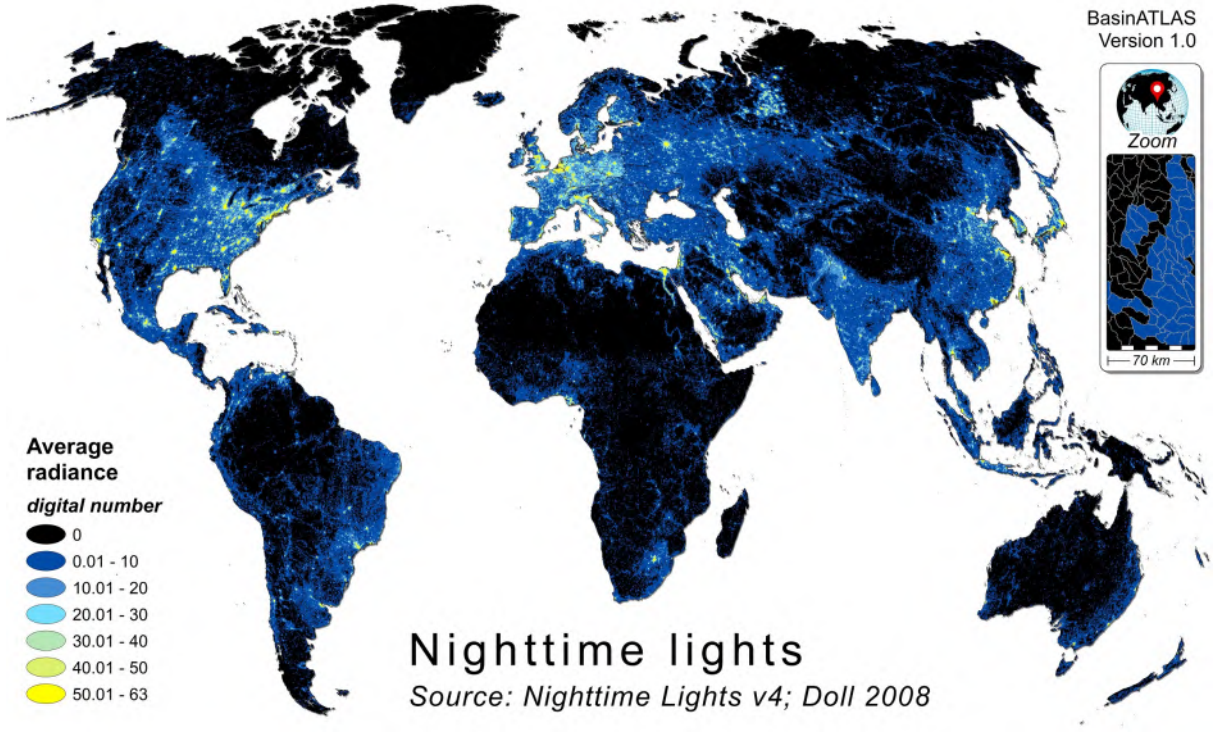
Citation: Doll 2008 ***Native format:*** 30 arc-second grid ***Units:*** index value (x100)

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav | 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

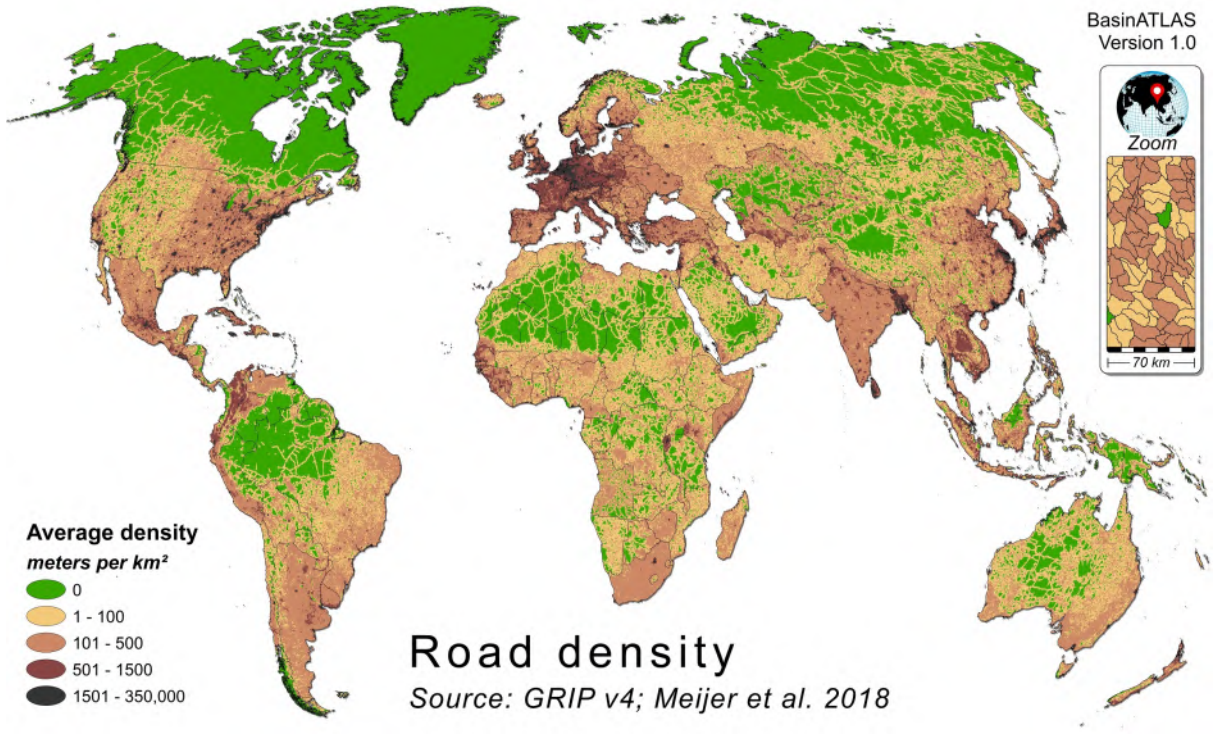
Citation: Meijer et al. 2018 ***Native format:*** 5 arc-min grid ***Units:*** meters per km²

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav | 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

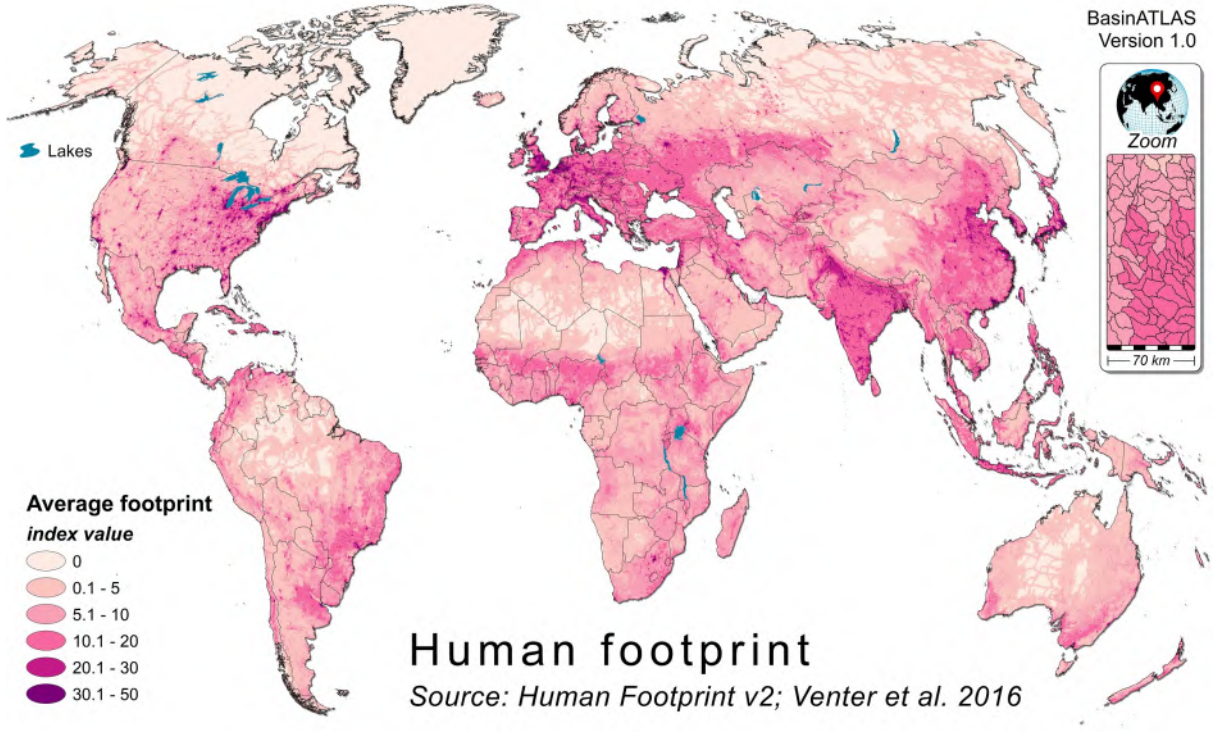
Citation: Venter et al. 2016 ***Native format:*** 30 arc-second grid ***Units:*** index value (x10)

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

Spatial extent {x}: {s} in sub-basin | {u} in total watershed upstream of sub-basin pour point

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

Existing suffixes {xoo}: s93 | u93 | s09 | 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

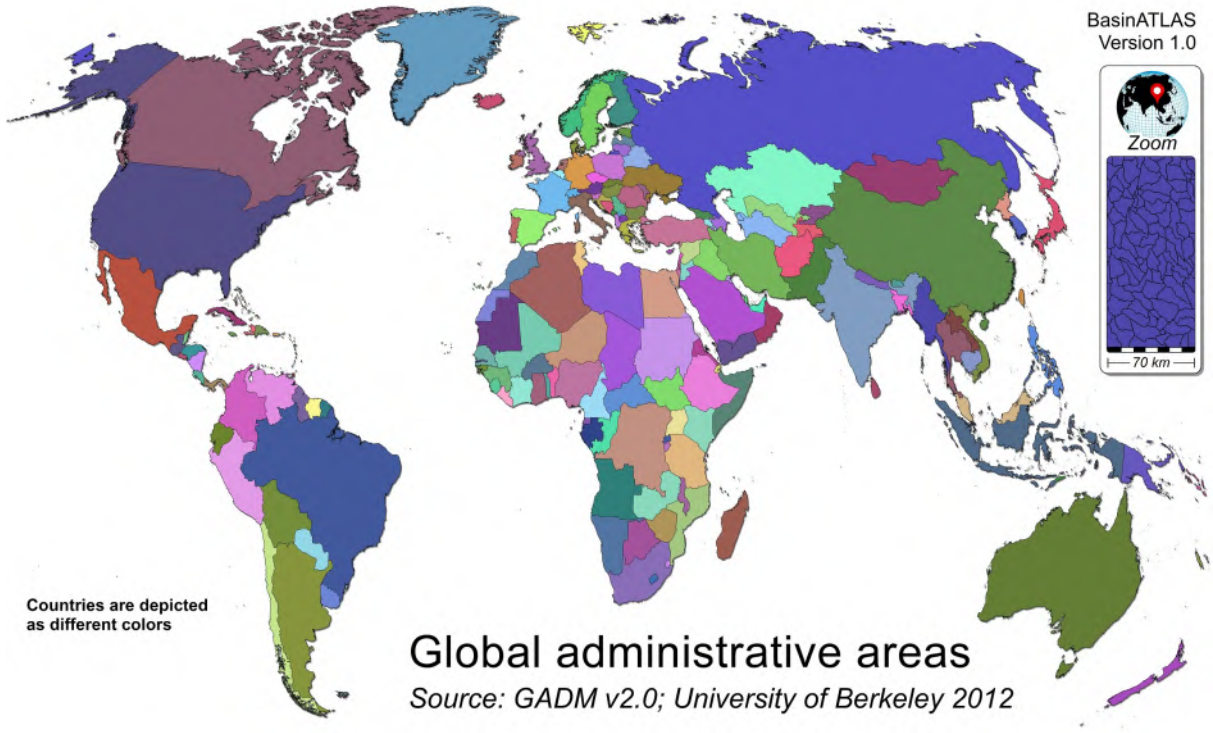
Citation: University of Berkeley 2012 ***Native format:*** Polygons ***Units:*** ID number

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {mj} spatial majority

Existing suffixes {xoo}: smj



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/

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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

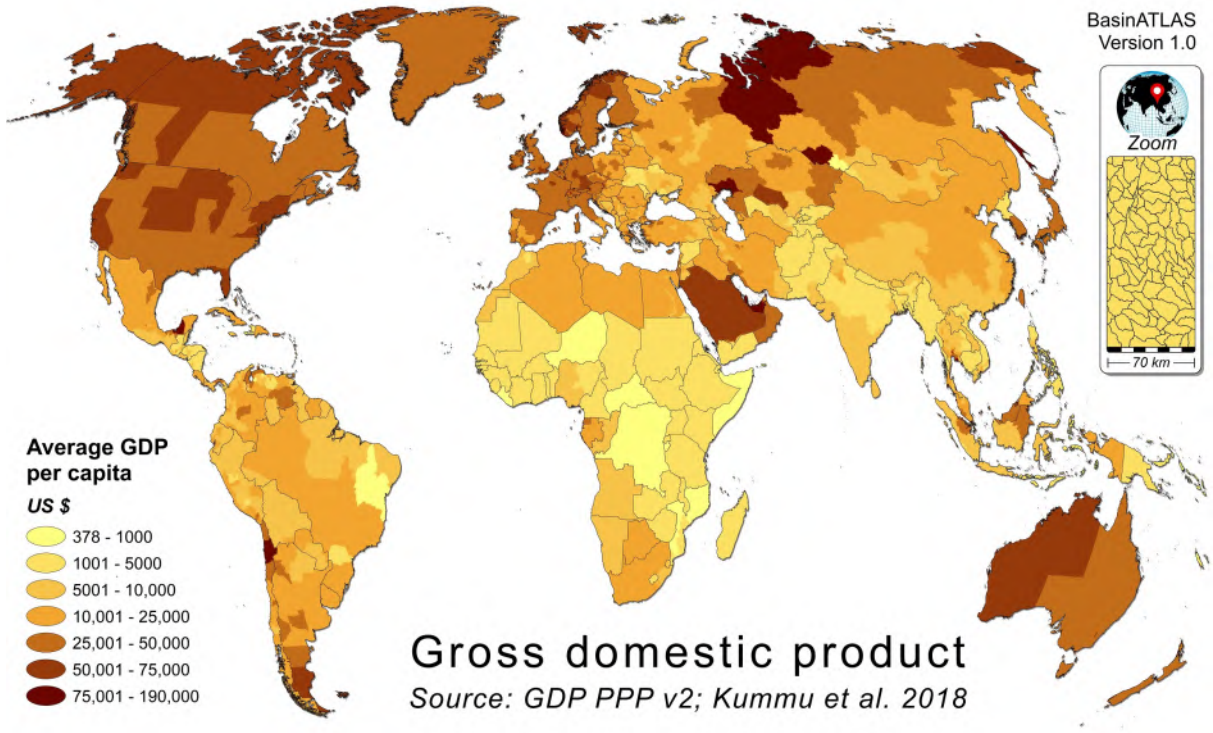
Citation: Kummu et al. 2018 ***Native format:*** 5 arc-min grid ***Units:*** US dollars

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

Spatial extent {x}: {s} in sub-basin

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

Existing suffixes {xoo}: sav | ssu | 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

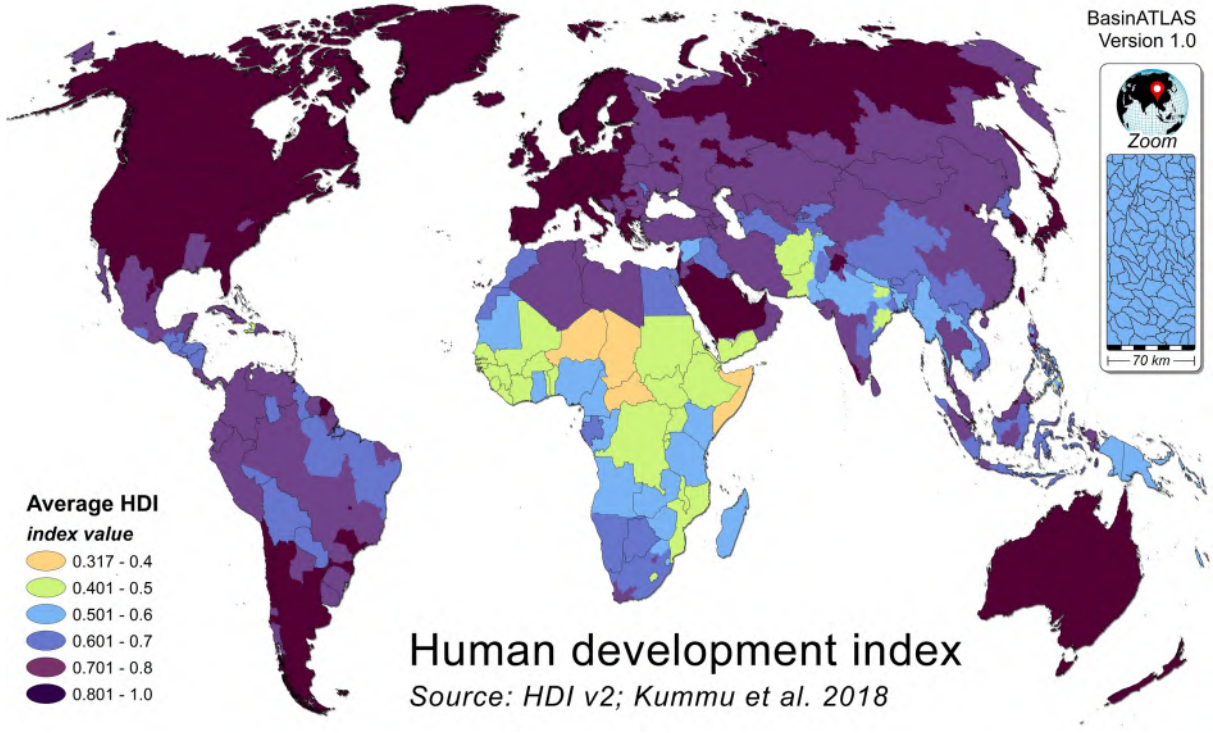
Citation: Kummu et al. 2018 ***Native format:*** 5 arc-min grid ***Units:*** index value (x1000)

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

Spatial extent {x}: {s} in sub-basin

Dimension {oo}: {av} average

Existing suffixes {xoo}: sav



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).