Data description to "Catchment attributes and hydro-meteorological time series for large-sample studies across hydrologic Switzerland (CAMELS-CH)"

Marvin Höge[1], Martina Kauzlaric[2,13], Rosi Siber[1], Ursula Schönenberger[1], Pascal Horton[2,13], Jan Schwanbeck[2], Marius Günter Floriancic[3], Daniel Viviroli[4], Sibylle Wilhelm[2], Anna E. Sikorska-Senoner[5,6], Nans Addor[7,8], Manuela Brunner[3,9,10], Sandra Pool[11], Massimiliano Zappa[12], and Fabrizio Fenicia[1]

[1]Eawag, Dübendorf, Switzerland
[2]Geographisches Insitut, Universität Bern, Bern, Switzerland
[3]ETH Zürich, Zürich, Switzerland
[4]Universität Zürich, Zürich, Switzerland
[5]Federal Office of Meteorology and Climatology MeteoSwiss, Zurich-Airport, Switzerland
[6]Center for Climate Systems Modeling C2SM, ETH Zurich, Zurich, Switzerland
[7]Fathom, Bristol, UK
[8]University of Exeter, Exeter, UK
[9]WSL Institute for Snow and Avalanche Research SLF, Davos Dorf, Switzerland
[10]Climate Change, Extremes and Natural Hazards in Alpine Regions Research Center CERC, Davos Dorf, Switzerland
[11]University of Melbourne, Melbourne, Australia
[12]WSL, Birmensdorf, Switzerland
[13]Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland

Correspondence: Marvin Höge (marvin.hoege@eawag.ch)

Data Description

This is a data description summary for the CAMELS-CH data set that corresponds to the official CAMELS-CH publication (currently under review at ESSD, with the final DOI being posted here). The summary provides an overview of the content of the *camels_ch.zip* file in this data repository and therefore comprises the tables shown in the article. For details about the data sources and further explanations refer to the respective sections in the article.

1 Catchments

The folder *catchment_delineations* in *camels_ch.zip* contains all shapefiles of the basins, sub-basins (that are non-nested) and gauging stations covered by CAMELS-CH. This comprises 298 river catchments and 33 lakes. All lakes are located within political Switzerland as well as 195 river catchments. The other 103 catchments are located as follows: Austria (34 catchments), France (32), Germany (26) and Italy (11).

2 Daily time series

The folder *time_series* in *camels_ch.zip* contains two subfolders *observation_based* and *simulation_based*. These comprise, respectively, observation-based and a simulation-based time series of hydro-meteorological variables for each catchment over a period from 1. January 1981 to 31. December 2020 as specified in Table 1.

Table 1. Catchment-specific hydro-meteorological variables available as daily time series in CAMELS-CH

Time series class	Time series names	Description	Unit	Data Source
Hydrological time series (1. Jan. 1981 - 31. Dec. 2020)	discharge_vol	observed catchment discharge	$m^3\ s^{-1}$	Swiss Federal Office for the Environment (FOEN, 2023) and neighbouring countries*
	discharge_spec	observed catchment-specific discharge (converted to millimetres per day using catchment areas)	$mm\ d^{-1}$	
	waterlevel	observed daily water head above sea level	m	
	discharge_vol_sim	simulated daily averaged absolute discharge	$m^3\ s^{-1}$	Precipitation-Runoff-Evapotranspiration Hydrotope (PREVAH) model (Viviroli et al., 2007)
	discharge_spec_sim	simulated daily averaged discharge normalized by catchment area	$mm\ d^{-1}$	
Meteorological time series (1. Jan. 1981 - 31. Dec. 2020)	precipitation	observed daily summed precipitation	$mm\ d^{-1}$	Swiss Federal Office of Meteorology and Climatology (MeteoSwiss, 2023)
	temperature_min	observed daily minimum temperature	°C	
	temperature_mean	observed daily averaged temperature	°C	

Table 1 – continued from previous page

Time series class	Time series names	Description	Unit	Data Source
	temperature_max	observed daily maximum temperature	°C	
	rel_sun_dur	observed daily averaged relative sunshine (solar irradiance ≥ 200 W m^{-2}) duration	%	
	swe	observed daily averaged snow water equivalent	mm	Swiss WSL Institute for Snow and Avalanche Research (SLF, 2023)
	precipitation_sim	simulated daily averaged precipitation	mm d^{-1}	Precipitation-Runoff-Evapotranspiration Hydrotope (PREVAH) model (WINMET tool; Viviroli et al., 2007)
	temperature_sim	simulated daily averaged temperature	°C	
	radiation_sim	simulated daily averaged global radiation	W m^{-2}	
	sun_duration_sim	simulated daily averaged sunshine duration	h	
	wind_sim	simulated daily averaged wind speed	m s^{-1}	
	rel_humidity_sim	simulated daily averaged relative humidity	%	
	pet_sim	simulated daily averaged potential evapotranspiration (Penman-Monteith equation without interception correction)	mm d^{-1}	
	et_sim	simulated daily averaged actual evapotranspiration	mm d^{-1}	

Table 1 – continued from previous page

Time series class	Time series names	Description	Unit	Data Source
	intercept_et_sim	simulated daily averaged intercepted evapotranspiration	mm d^{-1}	
	intercept_storage_sim	simulated daily averaged intercept storage	mm	

*Hydrologic discharge timeseries for catchments outside of political Switzerland available as download or received upon personal request (see Kauzlaric et al., 2023) from

- Austria: Office of the Federal State of Vorarlberg, Division of Water Management, Bregenz (VRB, 2020, incl. personal request) and 15 catchments from LamaH (Klingler et al., 2021), i.e. gauge_ids: 3001, 3004, 3006, 3007, 3008, 3009, 3012, 3014, 3015, 3019, 3023, 3028, 3031, 3032, 3033.
- France: French database of discharge measurements (BanqueHydro, 2020)
- Germany: State Agency for the Environment Baden-Württemberg – Hydrographic Service, Karlsruhe (LUBW, 2020) and Bavarian State Office for the Environment – Hydrographic Service, Munich (GKDB, 2020)
- Italy: Regional agency for environmental protection for the region Lombardia, Milano (ARPALombardia, 2020, incl. personal request) and Regional agency for environmental protection for the region Piemonte, Torino (ARPAPiemonte, 2020, incl. personal request)

3 Annual time series

The folder *annual_time_series* in *camels_ch.zip* contains annual time series between 1981 and 2020 of two the two attribute classes "Glacier" and "Land Cover" as specified in Table 2 for each catchment. The respective attributes that are available as static attributes refer to the year 2000, see Section 5.

4 Original glacier data

The folder *glacier_data_original* in *camels_ch.zip* contains the data from the used glacier data sources (GLAMOS, 2016; Paul et al., 2019) and processing information. While this information refers to the individual glaciers, the glacier data in CAMELS-CH is aggregated per catchment.

5 Catchment attributes

The folder *static_attributes* in *camels_ch.zip* comprises static catchment attributes for all 331 basins as specified in Table 2. Further, it contains two subfolders *supplements* (see Section 5.1 below) and *simulation_based* (that contains static attributes for classes "Climate" and "Hydrology" derived from simulation-based data).

Table 2. Catchment-specific static attributes available in CAMELS-CH (*Soil attributes: each soil type/property is accompanied by percentiles (5, 25, 50, 75, 90), distribution skewness and missing percentage across the catchment) with additional annual time series available for glacier and land cover attributes (see Section 3)

Attribute class	Attribute name	Description	Unit	Data Source
Location and topography	gauge_id	catchment identifier according to FOEN notation, adjusted to neighbouring countries	–	Swiss Federal Office for the Environment (FOEN, 2023) and neighbouring countries resources as specified in Section 2
	country	country of gauging station	–	
	gauge_name	gauging station name	–	
	water_body_name	water body name	–	
	id6	identifier based on gauging station and water body names	–	
	water_body_type	water body type (stream or lake)	–	
	gauge_lon	gauging station longitude	°	
	gauge_lat	gauging station latitude	°	
	gauge_easting	gauging station easting	m	
	gauge_northing	gauging station northing	m	
	gauge_elevation	gauging station elevation	m.a.s.l.	
	area	catchment area	km^2	

Table 2 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
	elev_mean	mean elevation within catchment	m.a.s.l.	Swiss Federal Office of Topography (swisstopo, 2015) / EU digital elevation model (v1.1; EU-DEM, 2016)
	elev_min	minimum elevation within catchment	m.a.s.l.	
	elev_percentiles	elevation percentiles (10, 25, 50, 75 and 90 %)	m.a.s.l.	
	elev_max	maximum elevation within catchment	m.a.s.l.	
	slope_mean	catchment mean slope over all grid cells	°	
	flat_area_perc	percentage of catchment area with slope smaller than 3°	%	
	steep_area_perc	percentage of catchment area with slope greater than 15°	%	
Climate	ind_start_date	start date for indices calculation	–	MeteoSwiss (2023, observation-based attributes) / PREVAH (WINMET tool; Viviroli et al., 2007, simulation-based attributes)
	ind_end_date	end date for indices evaluation	–	
	ind_number_of_years	number of years for indices evaluation	–	
	p_mean	mean daily precipitation	mm d^{-1}	

Table 2 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
	pet_mean	mean daily potential evapotranspiration (PET; Penman-Monteith equation without interception correction)	mm d^{-1}	
	aridity	aridity (ratio of mean daily PET to mean daily precipitation)	–	
	p_seasonality	seasonality and timing of precipitation (estimated using sine curves to represent the annual temperature and precipitation cycles, positive (negative) values indicate that precipitation peaks in summer (winter), and values close to zero indicate uniform precipitation throughout the year). See Eq. (14) in Woods (2009))	–	
	frac_snow	fraction of precipitation falling as snow, i.e. while temperature is $< 0°C$	–	
	high_prec_freq	frequency of high-precipitation days (≥ 5 times mean daily precipitation)	d yr^{-1}	
	high_prec_dur	average duration of high-precipitation events (number of consecutive days ≥ 5 times mean daily precipitation)	d	

Table 2 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
	high_prec_timing	season during which most high-precipitation days occur, e.g. 'jja' for summer. If two seasons register the same number of events a value of NA is given.	season	
	low_prec_freq	frequency of dry days (< 1 mm d^{-1})	d yr^{-1}	
	low_prec_dur	average duration of dry periods (number of consecutive days < 1 mm d^{-1} mean daily precipitation)	d	
	low_prec_timing	season during which most dry days occur, e.g. 'son' for autumn. If two seasons register the same number of events a value of NA is given.	season	
Hydrology	sign_start_date	start date for signature evaluation	–	FOEN (2023, observation-based attributes) / PREVAH model (Viviroli et al., 2007, simulation-based attributes)
	sign_end_date	end date for signature evaluation	–	
	sign_number_of_years	number of years for signature evaluation	–	
	q_mean	mean daily specific discharge	mm d^{-1}	
	runoff_ratio	runoff ratio (ratio of mean daily discharge to mean daily precipitation)	–	

Table 2 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
	stream_elas	stream flow precipitation elasticity (sensitivity of stream flow to changes in precipitation at the annual timescale, using mean daily discharge as reference, see Coxon et al. (2020) and reference therein)	–	
	slope_fdc	slope of the flow duration curve (between the log-transformed 33rd and 66th stream flow percentiles, see Coxon et al. (2020) and reference therein)	–	
	baseflow_index_landson	base flow index (see Coxon et al. (2020) and reference therein)	–	
	hfd_mean	mean half-flow date (number of days since 1. Oct at which the cumulative discharge reaches half of the annual discharge)	d	
	Q5	5 % flow quantile (low flow)	mm d^{-1}	
	Q95	95 % flow quantile (high flow)	mm d^{-1}	
	high_q_freq	frequency of high-flow days (> 9 times the median daily flow)	d yr^{-1}	

Table 2 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
	high_q_dur	average duration of high-flow events (number of consecutive days > 9 times the median daily flow)	d	
	low_q_freq	frequency of low-flow days (< 0.2 times the mean daily flow)	d yr^{-1}	
	low_q_dur	average duration of low-flow events (number of consecutive days < 0.2 times the mean daily flow)	d	
	zero_q_freq	fraction of days with zero stream flow	–	
Soil*	sand_perc	percentage sand	%	EU-SoilHydroGrids (2017) / European Soil Database Derived (ESDD) data (ESDD, 2013)
	silt_perc	percentage silt	%	
	clay_perc	percentage clay	%	
	organic_perc	percentage organic material	%	
	coarse_fragm_perc	percentage coarse fragments	%	
	bulk_dens	bulk density	g cm^{-3}	
	tot_avail_water	total available water content	mm	
	porosity	volumetric porosity	–	
	conductivity	saturated hydraulic conductivity	cm h^{-1}	
	root_depth	depth available for roots	m	

Table 2 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
Hydrogeology	unconsol_coarse_perc	well permeable gravel in valley bottoms	%	Hydrogeologic Maps of Switzerland (geo.admin.ch, 2016) and Germany (GDK, 2019)
	unconsol_medium_perc	permeable gravel outside of valley bottoms, sandy gravel, medium- to coarse-grained gravel	%	
	unconsol_fine_perc	loamy gravel, fine- to medium-grained debris, moraines	%	
	unconsol_imperm_perc	clay, silt, fine sands and loamy moraines	%	
	hardrock_perc	fissured and porous, non-karstic hard rock: conglomerates, sandstone, limestone with marl layers; crystalline rock: granite, granodiorites, tonalite	%	
	hardrock_imperm_perc	marl, shale, gneiss and cemented sandstone	%	
	karst_perc	carbonate rock: limestone, dolomite, rauhwacke; sulphate-containing rock: gypsum, anhydrite	%	
	water_perc	glaciers, firn, surface waters	%	
	null_perc	without defined hydrogeology	%	

Table 2 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
	ext_area_perc	catchment areal percentage not covered by the data source	%	
Geology	geo_porosity	average catchment geologic porosity	−	GLHYMPS 2.0 (Huscroft et al., 2018)
	geo_log10_permeability	average logarithmic catchment geologic permeability	$\log_{10}(\mathrm{m}^2)$	
	unconsol_sediments	percentage of unconsolidated sediments	%	GLiM (Hartmann and Moosdorf, 2012)
	siliciclastic_sedimentary	percentage of siliciclastic sedimentary rocks	%	
	mixed_sedimentary	percentage of mixed sedimentary rocks	%	
	carbonate_sedimentary	percentage of carbonate sedimentary rocks	%	
	pyroclastic	percentage of pyroclastics	%	
	acid_volcanic	percentage of acid volcanic rocks	%	
	basic_volcanic	percentage of basic volcanic rocks	%	
	acid_plutonic geo_pa	percentage of acid plutonic rocks	%	
	intermediate_plutonic	percentage of intermediate plutonic rocks	%	
	basic_plutonic	percentage of basic plutonic rocks	%	
	metamorphics	percentage of metamorphics	%	
	water_geo	percentage of water bodies	%	

Table 2 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
	ice_geo	percentage of ice and glaciers	%	
Glacier	glac_area_ch	glacier area of Swiss glaciers per catchment	km^2	Swiss Glacier Inventory (GLAMOS, 2016)
	glac_vol_ch	glacier volume of Swiss glaciers per catchment	km^3	
	glac_mass_ch	glacier mass of Swiss glaciers per catchment	MT (10^6 metric tons)	
	glac_area_neighbours	glacier area of glaciers attributed to neighbouring countries (Austria, France, Italy)	km^2	Paul et al. (2019)
Land cover	crop_perc	percentage of agriculture	%	Copernicus: Corine Land Cover (CLC, 2000)
	grass_perc	percentage of grass and herb vegetation	%	
	shrub_perc	percentage of medium-scale vegetation	%	
	dwood_perc	percentage of deciduous forest	%	
	mix_wood_perc	percentage of mixed forest	%	
	ewood_perc	percentage of coniferous forest (evergreen)	%	
	wetlands_perc	percentage of wetlands	%	
	inwater_perc	percentage of inland water	%	
	ice_perc	percentage of glaciers and perpetual snow	%	
	loose_rock_perc	percentage of loose rocks and bare soils	%	

Table 2 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
	rock_perc	percentage of hard rocks and bare soils	%	
	urban_perc	percentage of urban and settlements	%	
	dom_land_cover	dominant land cover type	–	
Human impact	n_inhabitants	population in catchment area	–	Geostat population grid (eurostat, 2018)
	dens_inhabitants	population density in catchment area	km^{-2}	
	num_reservoir	number of reservoirs	–	Swiss Federal Office of Energy (SFOE, 2020)
	reservoir_cap	total storage capacity of reservoirs in megalitres	ML	
	reservoir_he	percentage of total reservoir storage used for hydroelectricity	%	
	reservoir_fs	percentage of total reservoir storage used for flood storage	%	
	reservoir_irr	percentage of total reservoir storage used for irrigation	%	
	reservoir_nousedata	percentage of total reservoir storage where no use data were available	%	
	reservoir_year_first	year the first reservoir was built	%	
	reservoir_year_last	year the last reservoir was built	%	

Table 2 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
	hp_count	number of hydropower plants in the catchment with at least 300 kW installed capacity	–	Swiss Federal Office of Energy (SFOE, 2022)
	hp_qturb	sum of discharge capacity	$m^3\ s^{-1}$	
	hp_inst_turb	installed capacity	MW	
	hp_max_power	maximal bottleneck capacity	MW	

5.1 Supplementary catchment attributes

For the three categories "location and topography", "soil" and "geology", CAMELS-CH provides supplementary attributes to account for the special Alpine environment.

Table 3. Supplementary catchment-specific static attributes (*Suppl. soil attributes: each soil type/property is accompanied by percentiles (5, 25, 50, 75, 90), distribution skewness and missing percentage across the catchment)

Attribute class	Attribute name	Description	Unit	Data Source
Suppl. location and topography	gauge_id	catchment identifier according to FOEN notation, adjusted to neighbouring countries	–	Swiss Federal Office for the Environment (FOEN, 2023) / Swiss Federal Office of Topography (swisstopo, 2022)
	gauge_easting_old	gauging station easting in the old Swiss coordinate system LV03	m	
	gauge_northing_old	gauging station northing in the old Swiss coordinate system LV03	m	
	hierarchy_lower	catchment hierarchy lower bound	–	
	hierarchy_upper	catchment hierarchy upper bound	–	
	river_basin	large pan-European river basin that drains the catchment	–	

Table 3 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
	river_basin_ch	pan-Switzerland river basin that drains the catchment	–	
	sub_gauge_id		–	
	sub_area		km^2	
	frac_ch	catchment fraction within Switzerland	–	
	frac_de	catchment fraction within Germany	–	
	frac_at	catchment fraction within Austria	–	
	frac_li	catchment fraction within Liechtenstein	–	
	frac_it	catchment fraction within Italy	–	
	frac_fr	catchment fraction within France	–	
	ext_r1981	catchment fraction covered by gridded rainfall data from 1981 until 1991	%	Swiss Federal Office of Meteorology and Climatology (MeteoSwiss, 2023)
	ext_r1992	catchment fraction covered by gridded rainfall data from 1992 until 2020	%	
	ext_tabs	catchment fraction covered by gridded temperature data	%	
	ext_srel	catchment fraction covered by gridded relative sunshine duration data	%	
	ext_sim	catchment fraction covered by the simulation-based meteorologic variables	%	PREVAH model (WINMET tool; Viviroli et al., 2007)
Suppl. soil*	sg_sand_perc	percentage sand	%	SoilGrids (2020)

Table 3 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
	sg_silt_perc	percentage silt	%	
	sg_clay_perc	percentage clay	%	
	sg_organic_perc	percentage organic material	%	
	sg_bulk_dens	bulk density	g cm^{-3}	
	sg_tot_avail_water	total available water content	mm	
	sg_root_depth	depth available for roots	m	
	sg_soil_depth	depth of soil	m	
Suppl. geology	geo_osm	Upper Freshwater Molasse	%	Swiss Geological Map (map.geo.admin.ch, 2021) / Geological 3D model of the Swiss Plateau (GeoMol, 2021)
	geo_omm	Upper Marine Molasse	%	
	geo_usm	Lower Freshwater Molasse	%	
	geo_api	Autochtone - Parautochtone, Infrahelvetic Nappes	%	
	geo_amk	Allochthone Massive and Infrapenninic Crystallin Nappes	%	
	geo_sus	South- to Ultrahelvetic Sedimentary Nappes & Scales	%	
	geo_dup	Nappes of the Lower Eastalpine-Penninic Boundary Zone	%	
	geo_sal	Southalpine	%	
	geo_oos	Ophiolite containing Upperpenninic Sedimentary Nappes & Scales	%	
	geo_mpk	Midpenninic Crystallin Nappes	%	
	geo_aap	Outeralpine Plateau	%	

Table 3 – continued from previous page

Attribute class	Attribute name	Description	Unit	Data Source
	geo_fju	Folded Jurassic	%	
	geo_hes	Helvetic Sedimentary Nappes s.str.	%	
	geo_mps	Midpenninic Sedimentary Nappes & Scale	%	
	geo_ups	Lower Penninic Sedimentary Nappes & Scale, Ophiolites	%	
	geo_ops	Upperpenninic Sedimentary Nappes	%	
	geo_tie	Tertiary Intrusives und Extrusives	%	
	geo_ukd	Lower Penninic Crystallin Nappes	%	
	geo_uod	Lower Eastapline Nappes	%	
	geo_ood	Upper Eastapline Nappes	%	
	geo_qua	Quarternary Deposits	%	

References

ARPALombardia: https://www.arpalombardia.it/Pages/Acque-Superficiali/Quantita/Webgis.aspx?firstlevel=QuantitÃă, last access: 15. May 2023, 2020.

ARPAPiemonte: http://www.arpa.piemonte.it/rischinaturali/accesso-ai-dati/annali_meteoidrologici/annali-meteo-idro/banca-dati-idrologica.html, last access: 15. May 2023, 2020.

BanqueHydro: https://www.hydro.eaufrance.fr/, last access: 15. May 2023, 2020.

CLC: https://land.copernicus.eu/pan-european/corine-land-cover, cORINE land cover, last access: 15. May 2023, 2000.

Coxon, G., Addor, N., Bloomfield, J. P., Freer, J., Fry, M., Hannaford, J., Howden, N. J., Lane, R., Lewis, M., Robinson, E. L., et al.: CAMELS-GB: Hydrometeorological time series and landscape attributes for 671 catchments in Great Britain, Earth System Science Data, 12, 2459–2483, 2020.

ESDD: https://esdac.jrc.ec.europa.eu/content/european-soil-database-derived-data, European Soil Database Derived data, last access: 15. May 2023, 2013.

EU-DEM: https://land.copernicus.eu/imagery-in-situ/eu-dem/eu-dem-v1.1, last access: 15. May 2023, 2016.

EU-SoilHydroGrids: https://esdac.jrc.ec.europa.eu/content/3d-soil-hydraulic-database-europe-1-km-and-250-m-resolution, ver1.0, last access: 15. May 2023, 2017.

eurostat: https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/population-distribution-demography/geostat, (EU), last access: 15. May 2023, 2018.

FOEN: https://www.bafu.admin.ch/bafu/en/home.html, last access: 15. May 2023, 2023.

GDK: https://gdk.gdi-de.org/geonetwork/srv/api/records/61ac4628-6b62-48c6-89b8-46270819f0d6, hydrogeological Map of Germany (1:250'000), last access: 15. May 2023, 2019.

geo.admin.ch: http://map.geo.admin.ch/?layers=ch.swisstopo.geologie-hydrogeologische_karte-grundwasservorkommen, last access: 15. May 2023, 2016.

GeoMol: https://www.swisstopo.admin.ch/en/knowledge-facts/geology/geological-data/3d-geology/deep/geomol.html, last access: 15. May 2023, 2021.

GKDB: https://www.gkd.bayern.de/en/rivers/discharge/tables, last access: 15. May 2023, 2020.

GLAMOS: https://glamos.ch/en/downloads#inventories/B82-14, last access: 15. May 2023, 2016.

Hartmann, J. and Moosdorf, N.: The new global lithological map database GLiM: A representation of rock properties at the Earth surface, Geochemistry, Geophysics, Geosystems, 13, https://doi.org/https://doi.org/10.1029/2012GC004370, 2012.

Huscroft, J., Gleeson, T., Hartmann, J., and Börker, J.: Compiling and Mapping Global Permeability of the Unconsolidated and Consolidated Earth: GLobal HYdrogeology MaPS 2.0 (GLHYMPS 2.0), Geophysical Research Letters, 45, 1897–1904, https://doi.org/https://doi.org/10.1002/2017GL075860, 2018.

Kauzlaric, M., Schürmann, S., Ummel, D., and Zischg, A.: Hourly discharge database HydroCH, Zenodo, https://doi.org/10.5281/zenodo.7691294, 2023.

Klingler, C., Schulz, K., and Herrnegger, M.: LamaH-CE: LArge-SaMple DAta for hydrology and environmental sciences for central Europe, Earth System Science Data, 13, 4529–4565, 2021.

LUBW: http://udo.lubw.baden-wuerttemberg.de/public/p/pegel_messwerte_leer, last access: 15. May 2023, 2020.

map.geo.admin.ch: https://map.geo.admin.ch/?topic=geol&lang=en&bgLayer=ch.swisstopo.pixelkarte-grau&layers=ch.swisstopo.geologie-geologische_karte&catalogNodes=1786,1787, (1:500,000), last access: 15. May 2023, 2021.

MeteoSwiss: https://www.meteoswiss.admin.ch/#tab=forecast-map, last access: 15. May 2023, 2023.

Paul, F., Rastner, P., Azzoni, R. S., Diolaiuti, G., Fugazza, D., Le Bris, R., Nemec, J., Rabatel, A., Ramusovic, M., Schwaizer, G., and Smiraglia, C.: Glacier inventory of the Alps from Sentinel-2, shape files, PANGAEA, https://doi.org/10.1594/PANGAEA.909133, 2019.

SFOE: https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/geoinformation/geodata/water/water-retaining-facilities-subject-to-federal-supervision.html, last access: 15. May 2023, 2020.

SFOE: https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/geoinformation/geodata/water/hydropower-plants-statistics.html, last access: 15. May 2023, 2022.

SLF: https://www.slf.ch/en/index.html, last access: 15. May 2023, 2023.

SoilGrids: https://soilgrids.org/, version 2.0, last access: 15. May 2023, 2020.

swisstopo: https://www.swisstopo.admin.ch/de/geodata/maps/smv.html, last access: 15. May 2023, 2015.

swisstopo: https://www.swisstopo.admin.ch/en/geodata.html, last access: 15. May 2023, 2022.

Viviroli, D., , Gurtz, J., and Zappa, M.: The Hydrological Modelling System PREVAH), https://doi.org/10.4480/GB2022.P40, 2007.

VRB: https://vorarlberg.at/-/viid-abteilung-wasserwirtschaft-unsere-aufgaben, last access: 15. May 2023, 2020.