Supplement of

Res-CN: hydrometeorological time series and landscape attributes across 3254 Chinese reservoirs

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- Tables S2-8 describes the source datasets for generating reservoir water level, water area, storage variation, upstream catchment, catchment-level characteristics products as well as the buffer distance for calculating reservoir area series in this study.
- Tables S9-16 describes the attributes provided in our datasets.
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Figures

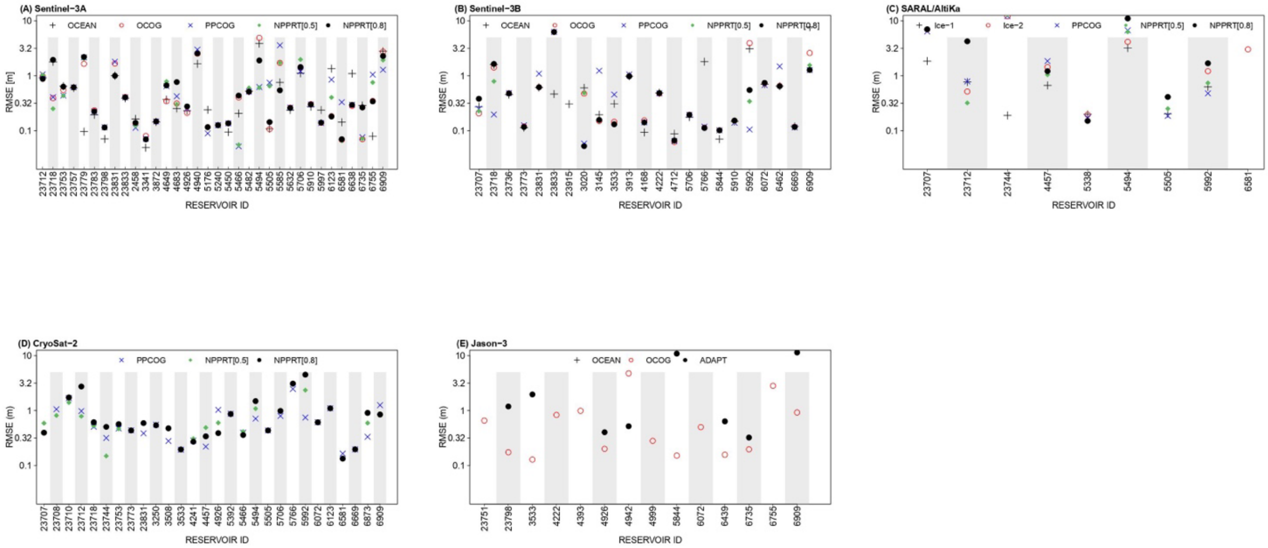


Figure S1. Performances of altimetry-derived water level from each satellite altimeters with different retracking algorithms.

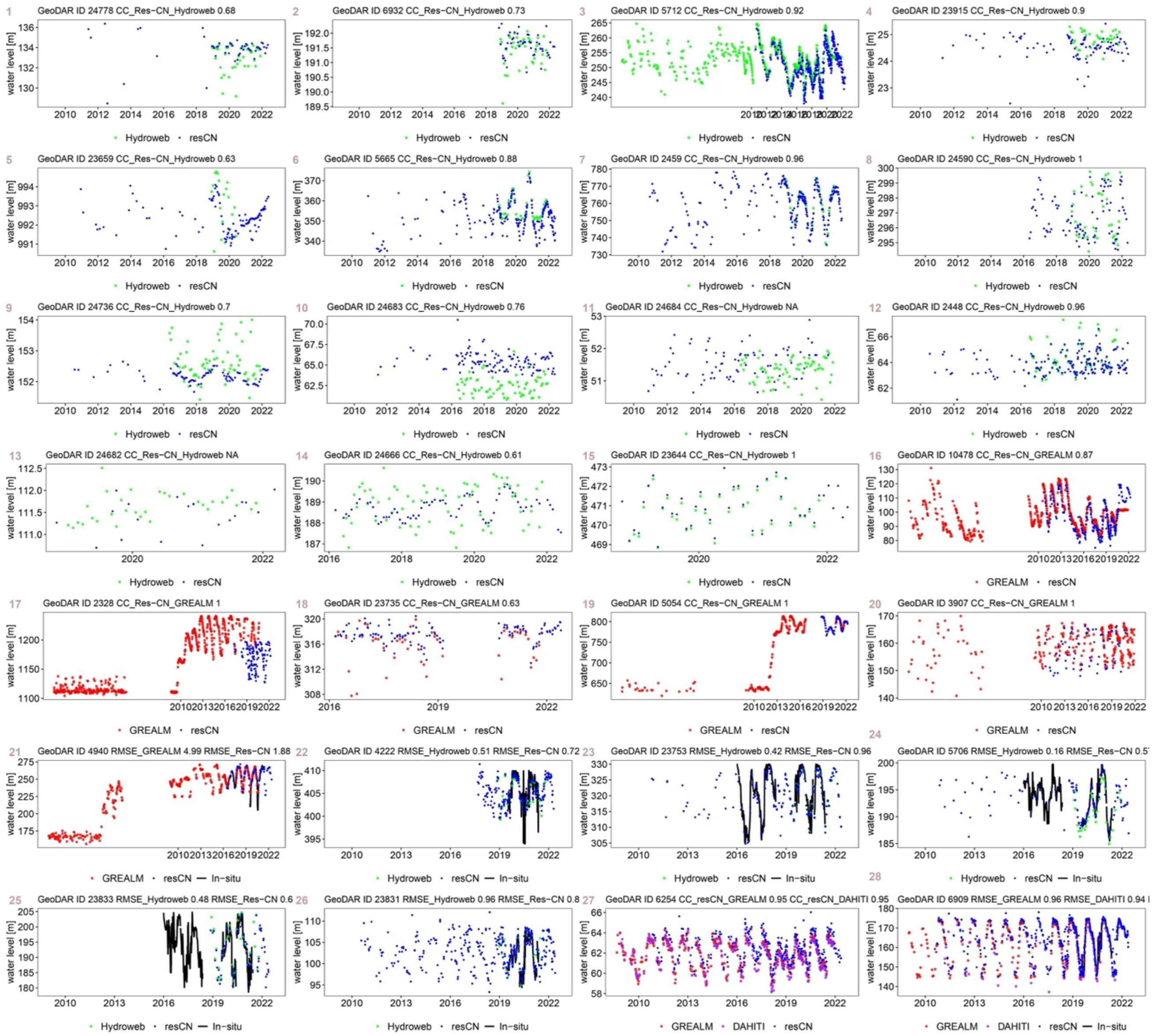


Figure S2. Comparison between our water level time series and other existing similar databases.

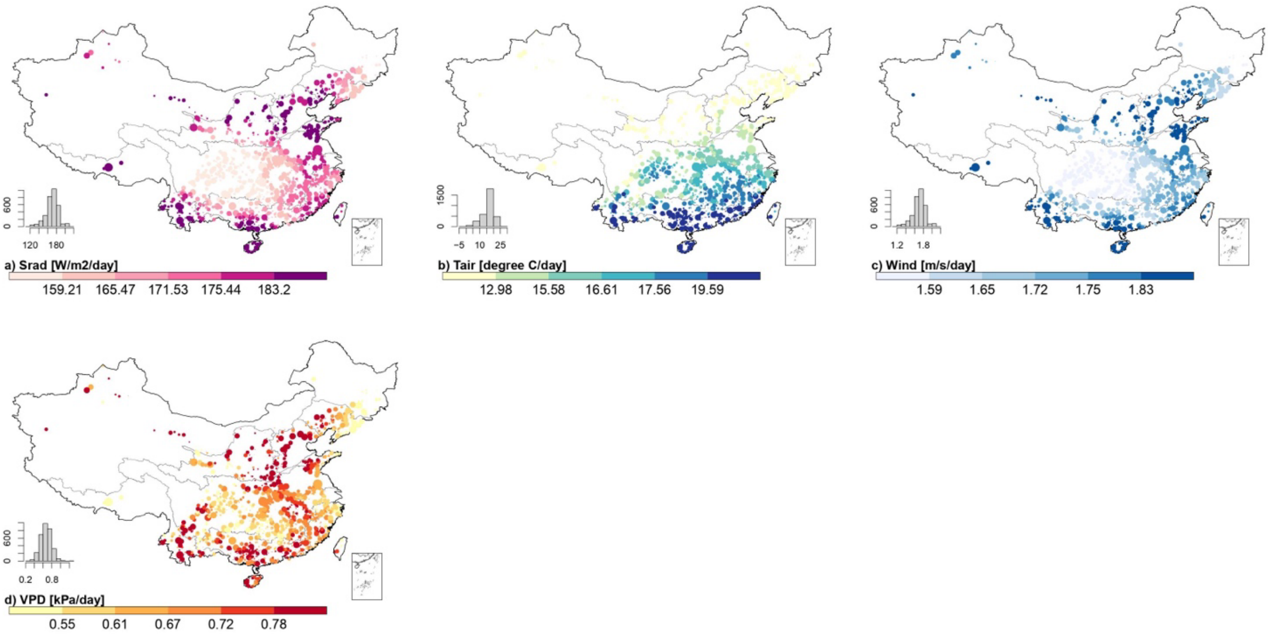


Figure S3. Long-term mean meteorological variables that were used to calculate the evaporation rates.

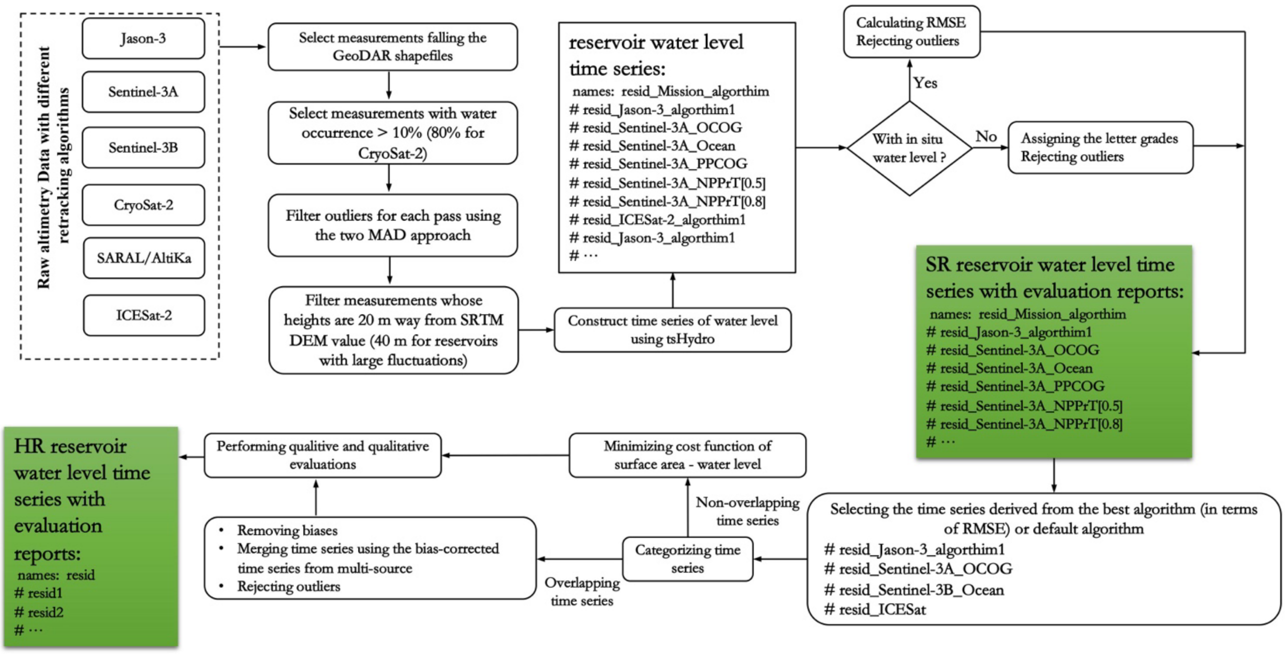


Figure S4. Flowchart of bias correction for obtaining SR and HR altimetric water level time series over reservoirs (Shen et al., 2022a).

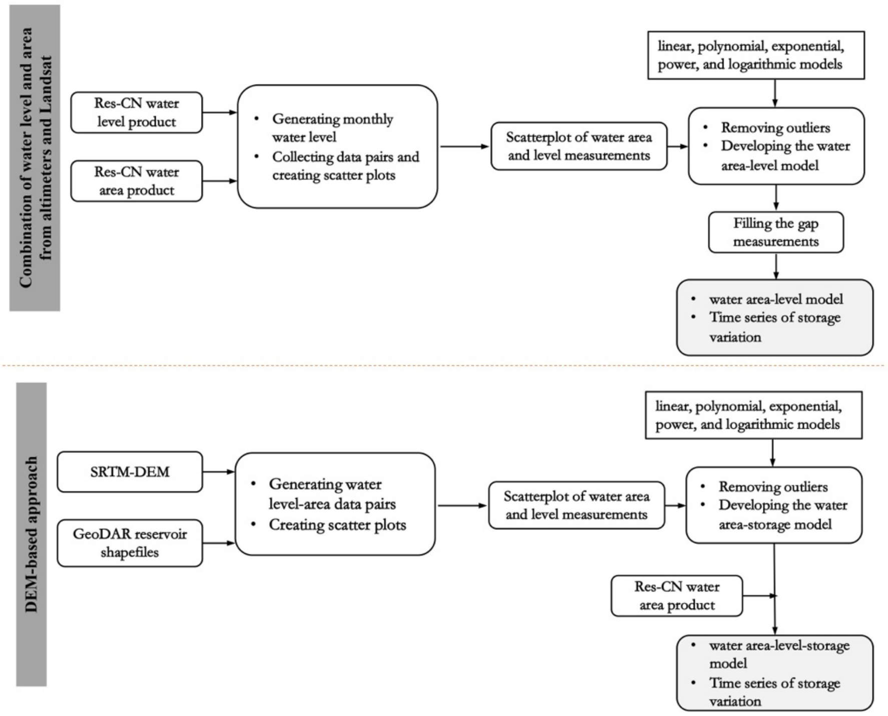


Figure S5. Flowchart of obtaining reservoir storage variation 1) using water levels from satellite altimetry and water areas from satellite imagery (top panel); and 2) using imagery-based water areas and SRTM-DEM (bottom panel). (Shen et al., 2022a).

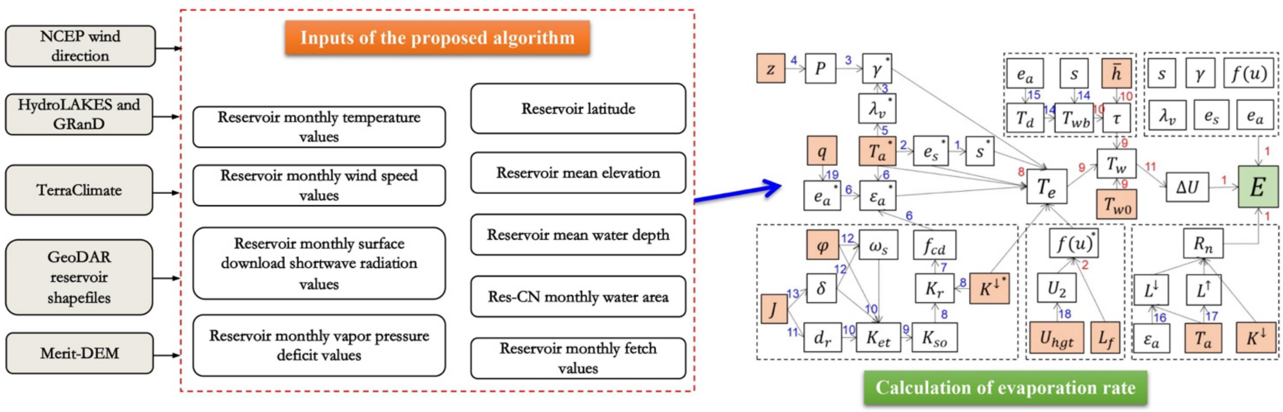


Figure S6. Flowchart of the proposed algorithm for generating time series of reservoir evaporation. For more details about the algorithm, evaporation calculation example, please find the https://ars.els-cdn.com/content/image/1-s2.0-S0034425719301063-mmc1.pdf.

Tables

Table S1. Providers of water level, area, storage variation, and evaporation time series for Chinese reservoirs.

Water levels:

Data sources	No. of reservoirs	Time and temporal resolution	Download link
Hydroweb	32	1992–2021, 10–35 day	http://hydroweb.theia-land.fr/
DAHITI	8	2002–2021, 10–35 day	https://dahiti.dgfi.tum.de/en/
G-REALM	~30	1992–2021, 10–35 day	https://ipad.fas.usda.gov/cropexplorer/global_reservoir
Tortini et al. (2020)	<10	1992–2018, sub-monthly	https://doi.org/10.5067/UCLRS-GREV2
Shen et al. (2022)	338	2010-2020, monthly	https://zenodo.org/record/5812012

Water areas:

Data sources	Number of reservoirs	Time and temporal resolution	Download link
Bluedot	/	2016–2021, sub-monthly	https://blue-dot-observatory.com/
GRASD	923	1984-2018, monthly	https://doi.org/10.18738/T8/DF80WG
Tortini et al. (2020)	<10	1992–2018, sub-monthly	https://doi.org/10.5067/UCLRS-AREV2
Donchyts et al. (2022)		1985-2021, monthly	https://doi.org/10.6084/m9.figshare.20359860
Yao et al. (2019)	~8	1992–2018, sub-monthly	https://lakewatch.users.earthengine.app/view/glats
Shen et al. (2022)	338	2010-2020, monthly	https://zenodo.org/record/5812012

Storage variations:

Data sources	Number of reservoirs	Time and temporal resolution	Download link
Vu et al. (2022)	10	2008-2020, monthly	https://doi.org/10.5281/zenodo.6299041
Tortini et al. (2020)	<10	1992–2018, sub-monthly	https://doi.org/10.5067/UCLRS-STOV2
Shen et al. (2021)	338	2010-2020, monthly	https://zenodo.org/record/5812012
Zhao et al. 2022	>4,000	1984-2020, monthly	https://doi.org/10.5281/zenodo.4646621

Evaporation:

Data sources	Number of reservoirs	Time and temporal resolution	Download link
Zhao et al. 2022	>4,000	1984-2020, monthly	https://doi.org/10.5281/zenodo.4646621
Tian et al., 2022	908	1984-2016, monthly	https://doi.org/10.5281/zenodo.6042127

Table S2. Source datasets for generating reservoir water level product in this study.

Satellite	Data period	Retracking algorithms	Repeat cycle
CryoSat-2	2010-2022.5	PPCOG, NPPTr[0.5], NPPTr[0.8]	369 days

SARAL/AltiKa	2016-2022.5	PPCOG, NPPTr[0.5], NPPTr[0.8], ICE-1, ICE-2	35 days
Sentinel-3A	2016.2-2022.5	PPCOG, NPPTr[0.5], NPPTr[0.8], OCOG, Ocean	27 days
Sentinel-3B	2018.4-2022.5	PPCOG, NPPTr[0.5], NPPTr[0.8], OCOG, Ocean	27 days
Jason-3	2016-2022.5	Adapt, OCOG, Ocean	10 days
ICESat-2	2018.10-2022.5	Official	90 days
In situ	2015-2021.5	- (99 reservoirs with observational water level records)	1 day
Global Surface Water Explorer	1984-2020	- (water occurrence product version 1.3)	-
SRTM-DEM	2000	-	-

Source download links:

- SARAL/AltiKa Geophysical Data Records (GDRs) from CNES AVISO+ at ftp://avisoftp.cnes.fr/AVISO/pub/
- CryoSat-2 baseline C level 1b dataset from ESA at https://science-pds.cryosat.esa.int/
- Sentinel-3 level 2 “Enhanced measurements” datasets from Copernicus Open Access Hub at https://scihub.copernicus.eu/dhus/.
- Jason-3 from https://www.aviso.altimetry.fr/en/missions/current-missions/jason-3.html
- ICESat-2 ATL13 product from https://icesat-2.gsfc.nasa.gov/science/data-products
- In situ water level for 99 reservoirs from the local governments at http://xxfb.mwr.cn/index.html and National Hydrological Information Centre at http://113.57.190.228:8001/web/Report/BigMSKReport
- Global Surface Water Explorer from the https://global-surface-water.appspot.com/.
- SRTM-DEM from the https://srtm.csi.cgiar.org/srtmdata/.

Table S3. Source datasets for generating reservoir water area product in this study.

Product	Data period	Remark	Download link
GeoDAR	-	Reservoir shapefiles	https://doi.org/10.5281/zenodo.6163413
JRC-GWSD	1984-2020	Two products are used: monthly history and water occurrence products	https://global-surface-water.appspot.com/

Table S4. Source datasets for generating reservoir storage variation product in this study.

Product	Data period	Remark	Download link
Res-CN water area	1984-2020	Generated in in this study	https://global-surface-water.appspot.com/
SRTM-DEM	2000	-	https://srtm.csi.cgiar.org/srtmdata/
In situ	2015-2021.5	139 reservoirs with daily water level and storage data	http://113.57.190.228:8001/web/Report/BigMSKReport http://xxfb.mwr.cn/index.html

Table S5. Source datasets for generating reservoir evaporation product in this study.

Satellite	Data period	Remark	Download link

GeoDAR	-	Reservoir shapefiles	https://doi.org/10.5281/zenodo.6163413
TerraClimate	1984-2020	Four variables: air temperature, wind speed, vapor pressure deficit, and surface downward shortwave radiation	https://climate.northwestknowledge.net/TERRACLIMATE/
Res-CN water area	1984-2020	Generated in in this study	https://global-surface-water.appspot.com/
NCEP	1984-2020	wind direction data from National Centers for Environmental Prediction	https://psl.noaa.gov/data/gridded/data.ncep.reanalysis.html
Merit-DEM	2019	To derive mean elevation	http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT_DEM/
HydroLAKES	-	To derive mean water depth	https://www.hydrosheds.org/products/hydrolakes
GRanD	-	To derive mean water depth	https://globaldamwatch.org/grand/

Table S6. Source datasets for generating reservoir upstream catchment product in this study.

Satellite	**Data period**	**Remark**	**Download link**
GeoDAR	-	Reservoirs and dams shapefiles	https://doi.org/10.5281/zenodo.6163413
Merit-Hydro	2019	Flow directions	http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT_Hydro/

Table S7. Source datasets for generating catchment-level characteristics product in this study.

Category	Source data	Remark	Download link
Topography	Merit-dem and Merit-Hydro	Yamazaki et al. (2017, 2019)	http://hydro.iis.u-tokyo.ac.jp/~yamadai/
	GeoDAR	Reservoir shapefiles	https://doi.org/10.5281/zenodo.6163413
	Our study	Catchment shapefiles	Provided in the main text.
Climate	National Station-based Climatic Data set V3	800 gauges offering 10 variables	closed
	Global Aridity Index and Global Reference Evapo-Transpiration	Zomer, R. J. (2022)	https://cgiarcsi.community/2019/01/24/global- aridity-index-and-potential-evapotranspiration-climate-database-v3/
Land cover	NPP, GPP, NDVI, LAI, EVI	Myneni et al., 2015; Didan, 2021; Running et al., 202a, b;	Available at GEE (original datasets and references are in the main texts)
	IGBP, Zeng, X. (2001)	Rooting depth	https://lpdaac.usgs.gov/products/mcd12q1v006/
	ESA WorldCover 2020, 10m	10 Land cover types	https://worldcover2020.esa.int/
Soil	SoilGrids250m	Hengl et al. (2017)	https://files.isric.org/soilgrids/former/2017-03-10/data/
	Dai et al. (2019)	Soil hydraulic and thermal properties	http://globalchange.bnu.edu.cn/research/soil5.jsp
	Shangguan et al. (2013)	Soil property data	http://globalchange.bnu.edu.cn/research/soil2
Geology	GLHYMPS (Global HYdrogeology MaPS)	Gleeson et al. (2014)	https://borealisdata.ca/dataset.xhtml?persistentId=doi:10.5683/SP2/DLGXYO
	GliM (Global Lithological Map)	Hartmann and Moosdorf, 2012	https://doi.pangaea.de/10.1594/PANGAEA.788537
Anthropogenic activity characteristics	Gridded Population of the World (GPW)	Population amount in 2000, 2005, 2010, 2015, and 2020	https://sedac.ciesin.columbia.edu/
	Global Roads Inventory Project (GRIP) dataset	Road density	https://www.globio.info/download-grip-dataset
	Global Human Footprint v2	Human Footprint	https://sedac.ciesin.columbia.edu/data/set/wildareas-v2-human-footprint-geographic/data-download
	DMSP-OLS Nighttime Lights v4 dataset	Doll, 2008	https://eogdata.mines.edu/products/dmsp/

Table S8. Buffering distance for GeoDAR reservoir datasets.

Buffered distance (m)	Number of reservoirs	Reservoir area (km^2)
150	650	A<=0.1
250	1515	0.1<=A<=1
500	795	1<=A<=10
750	273	10<=A<=100
1000	21	100<=A<=1000

Table S9. Attributes of reservoirs provided in the Res-CN.

Attribute	Unit	Description and values
id_v11	-	Dam ID of GeoDAR version 1.1
id_grd_v13	-	GRanD ID of this dam if also included in GRanD v1.3
lat	degree	Latitude of the dam point
lon	degree	Longitude of the dam point
rv_mcm_v11	millions of m^3	Reservoir storage capacity taken from Wada et al. (2017) and GRanD v1.3
plg_a_km2	km^2	Area of the retrieved reservoir polygon
length	km	Perimeter of the reservoir
elev	m	Mean reservoir elevation from Merit-DEM (Yamazaki et al., 2019)
region	-	Reservoir-based River basins
reservoir_development_index	-	Ratio: perimeter of the reservoir / perimeter of the circle whose area is that of the reservoir

Note: missing or inapplicable values are filled by “-999”.

Table S10. Attributes of topography provided in the Res-CN.

Attribute	Unit	Description	Data source and reference
area_calc	km^2	Calculated catchment area	Merri-Hydro (Yamazaki et al., 2019), GeoDAR (Wang et al., 2022)
elev_mean	m	Mean catchment elevation	Merit-DEM (Yamazaki et al., 2019)
elev_max	m	Maximum catchment elevation	See above
elev_min	m	Minimum catchment elevation	See above
elev_med	m	Median catchment elevation	See above
elev_std	m	Standard deviation of elevation in catchment	See above
elev_ran	m	Range of catchment elevation (maximum minus minimum elevation)	See above
slope_mean	$m\ km^{-1}$	Mean catchment slope, Horn (1981)	See above
mvert_dist	km	Horizontal distance from the farthest point of the catchment to the corresponding gauge (length axis)	Merri-Hydro (Yamazaki et al., 2019)
mvert_ang	degree	Angle between the north direction and connection from farthest point of catchment to the corresponding gauge (length axis); e.g., direction from north (farthest catchment point) to south (gauge):180 degree, direction from east to west: 270 degree	See above
elon_ratio	-	Ratio: elongation ratio, i.e., ratio between the diameter of an equivalent circle and the area of the catchment area to its length, Schumm (1956)	Subramanya, K. (2013)
strm_dens	$km\ km^{-2}$	Ratio: stream density, i.e., ratio of lengths of streams and the catchment area	See above
strm_length	km	The length of the mainstream measured from the basin outlet to the remotest point on the basin boundary. The mainstream is identified by starting from the basin outlet and moving up the catchment.	See above
form_factor	-	Ratio: catchment area / $(\text{catchment length})^2$	See above
shape_factor	-	Ratio: $(\text{catchment length})^2$ / catchment area	See above
circulatory_ratio	-	Ratio: perimeter of the catchment / perimeter of the circle whose area is that of the basin	See above
res_ratio	-	Ratio: reservoir area / catchment area	Merri-Hydro (Yamazaki et al., 2019), GeoDAR (Wang et al., 2022)
relief	-	Ratio: mean catchment elevation / Maximum catchment elevation	See above

Table S11. Meteorological data provided in the Res-CN.

Variable	Unit	Description	Source
DOY	-	Day of year	-
pet_mean	mm/d	Mean daily PET (Penman–Monteith equation)	Subramanya (2013), Nation station-based climate data v3
ep	mm/d	Mean daily evaporation (observations)	Nation station-based climate data v3, 1980-2020
ts	°C	Mean, maximum, and minimum daily ground surface temperature	See above
prec_nscd	mm/d	Mean daily precipitation	See above
prs	hpa	Mean, maximum, and minimum daily ground surface pressure	See above
humid	-	Mean daily relative humidity	See above
sun	h	Mean daily sunshine duration	See above
ta	°C	Mean, maximum, and minimum daily temperature	See above
wind	m/s	Mean, and maximum daily wind speed	See above

Table S12. Climate indices provided in the Res-CN.

Attribute	Unit	Description	Data source
p_mean	mm/d	Mean daily precipitation[a]	Nation station-based climate data v3
et0_mean	mm/d	Mean daily reference evapotranspiration ET0[b]	Global Evapo-Transpiration (ET0) Database v3 (Zomer and Trabucco, 2022)
arid	-	Global Aridity Index Database v3[b]	Global Aridity Index Database v3 (Zomer and Trabucco, 2022)
p_season	-	Seasonality and timing of precipitation (estimated using sine curves) to represent the annual precipitation cycles; positive (negative) values indicate that precipitation sums are higher during summer (winter) months; values close to 0 indicate uniform precipitation throughout the year; Eq. (14) in Woods (2009)[a]	Nation station-based climate data v3
frac_snow	-	Fraction of precipitation falling as snow, i.e., falling on days with mean temperature below 0 °C[a]	See above
hi_prec_fr	$d\ yr^{-1}$	Frequency of high-precipitation days (≥ 5 times mean daily precipitation)[a]	See above
hi_prec_du	d	Mean duration of high-precipitation events (number of consecutive days with ≥ 5 times mean daily precipitation)[a]	See above
hi_prec_ti	season[c]	Season during which most high-precipitation days (≥ 5 times mean daily precipitation) occur[a]	See above
lo_prec_fr	$d\ yr^{-1}$	Frequency of dry days (< 1 mm/d precipitation)[a]	See above
lo_prec_du	d	Mean duration of dry precipitation events (number of consecutive days with < 1 mm/d precipitation)[a]	See above
lo_prec_ti	season[c]	Season during which most dry days (< 1 mm/d precipitation) occur[a]	See above

[a] Period 1 October 1990 to 30 September 2019. [b] Period 1970 to 2000. [c] List of abbreviations for seasons: djf – December–January–February, mam – March–April–May, jja – June–July–August, son – September–October–November.

Table S13. Attributes of land cover provided in the Res-CN.

Attribute	Unit	Description	Data source
lai_max	-	Maximum monthly mean of one-sided leaf area index (based on 12-monthly means)	MODIS MCD15A3H version 6.1
lai_min	-	Minimum monthly mean of one-sided leaf area index (based on 12-monthly means)	See above
lai_diff	-	Difference between maximum and minimum monthly mean of one-sided leaf area index (based on 12-monthly means)	See above
ndvi_max	-	Maximum monthly mean of NDVI (based on 12-monthly means)	MODIS MOD13Q1 version 6.1
ndvi_min	-	Minimum monthly mean of NDVI (based on 12-monthly means)	See above
evi_mean	-	Mean enhanced vegetation index	See above
gpp_mean	kg c m^{-2}	Mean gross primary production	MODIS MOD17A2H version 6
npp_mean	kg c m^{-2}	Mean net primary production	MODIS MOD17A3HGF version 6
root_depth_50	m	Root depth (percentiles = 50 % extracted from a root depth distribution based on IGBP land cover)	Eq. (2) and Table 2 in Zeng (2001)
root_depth_90	m	Root depth (percentiles = 99 % extracted from a root depth distribution based on IGBP land cover)	See above
dominant_type	-	Dominant Land class	ESA WorldCover 10 m
dominant_frac	-	Fraction of dominant class	See above
trees	-	Fraction of “trees” (trees)	See above
grassland	-	Fraction of “grassland” (grassland)	See above
cropland	-	Fraction of “cropland” (cropland)	See above
shrubland	-	Fraction of “shrubland” (shrubland)	See above
bu	-	Fraction of “built-up” (bu)	See above
bsv	-	Fraction of “barren sparse vegetation” (bsv)	See above
si	-	Fraction of “snow and ice” (si)	See above
oc	-	Fraction of “open wate” (oc)	See above
hw	-	Fraction of “herbaceous wetland” (hw)	See above
mangroves	-	Fraction of “mangroves” (mangroves)	See above
ml	-	Fraction of “moss and lichen” (ml)	See above

Table S14. Attributes of soil provided in the Res-CN.

Attribute	Unit	Description	Data source
bdod	kg dm-3	Bulk density of the fine earth fraction	SoilGrids250 m (Hengl et al., 2017)[a]
cec	cmol kg^{-1}	Cation exchange capacity of the soil	See above
soc	g kg^{-1}	Soil organic carbon content in the fine earth fraction	See above
phh2o	10	Soil pH in	See above
pdep	cm	Soil profile depth	Shangguan et al. (2013)
cl	%	Percentage of clay content of the soil material	See above
sa	%	Percentage of sand content of the soil material	See above
por	cm^3 cm^{-3}	Porosity	See above
si	%	Percentage of silt content of the soil material	See above
grav	%	Rock fragment content	See above
som	%	Soil organic carbon content	See above
log_k_s	cm d^{-1}	Log-10 transformation of saturated hydraulic conductivity	Soil hydraulic and thermal parameters (Dai et al., 2019)[a]
theta_s	cm^3 cm^{-3}	Saturated water content	See above
tksatu	W m^{-1} K^{-1}	Thermal conductivity of unfrozen saturated soils	See above
csol	$J/(m^3K)$	Volumetric heat capacity of soil solids in a unit soil volume	See above
lambda	-	Pore size distribution index for the Campbell model	See above
log_vgm_n	-	Log-10 transformation of a shape parameter for the VG model	See above
psi_s	cm	Saturated suction for the Campbell model	See above
tkdry	W m^{-1} K^{-1}	Thermal conductivity of dry soils	See above
tksatf	W m^{-1} K^{-1}	Thermal conductivity of frozen saturated soils	See above

[a] Soil layers at six intervals of 0–0.05, 0.05–0.15, 0.15–0.30, 0.30–0.60, 0.60–1.00, and 1.00–2.00m. We determined and recorded catchment soil characteristics for all these layers.

Table S15. Attributes of geology provided in the Res-CN.

Attribute	Unit	Description	Data source
permeability	m^2	Subsurface porosity	GLHYMPS (Gleeson, 2018)
porosity	-	Subsurface permeability (log-10)	See above
first_type	-	Dominant geological class	GLiM (Hartmann and Moosdorf, 2012)
first_frac	%	Fraction of "first_type"	See above
ig	%	Fraction of "ice and glacier" (ig)	See above
mt	%	Fraction of "metamorphic" (mt)	See above
pa	%	Fraction of "acid plutonic rocks" (pa)	See above
pb	%	Fraction of "basic plutonic rocks" (pb)	See above
pi	%	Fraction of "intermediate plutonic rocks" (pi)	See above
py	%	Fraction of "pyroclastics" (py)	See above
sc	%	Fraction of "carbonate sedimentary rocks" (sc)	See above
sm	%	Fraction of "mixed sedimentary rocks" (sm)	See above
ss	%	Fraction of "siliciclastic sedimentary rocks" (ss)	See above
su	%	Fraction of "unconsolidated sediments" (su)	See above
va	%	Fraction of "acid volcanic rocks" (va)	See above
vb	%	Fraction of "basic volcanic rocks" (vb)	See above
vi	%	Fraction of "intermediate volcanic rocks" (vi)	See above
nd	%	Fraction of "no data" (nd)	See above
wb	%	Fraction of "water bodies" (wb)	See above
ev	%	Fraction of "evaporites" (ev)	See above

Table S16. Attributes of anthropogenic activity provided in the Res-CN.

Attribute	Unit	Description	Data source
population	-	Population for the years 2000, 2005, 2010, 2015, and 2020	Gridded Population of the World (GPW) database v4.11
nli	-	Nighttime Lights (NLI)	DMSP-OLS Nighttime Lights v4 dataset (Doll, 2008)
road_density	$m\ km^{-2}$	Road density	Global Roads Inventory Project (GRIP) dataset (Meijer et al., 2018)
human_footprint	-	Human footprint	Global Human Footprint v2 dataset (Venter et al., 2016)

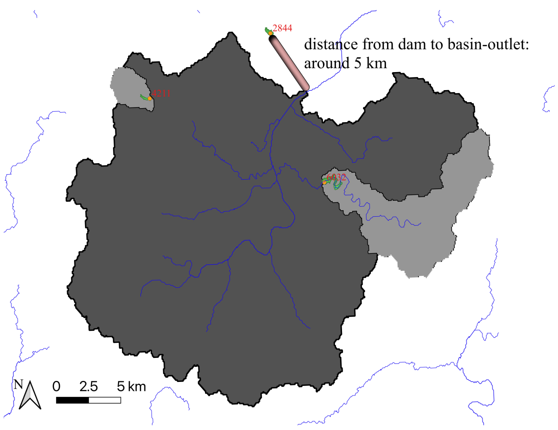
Texts

Text S1

The following steps details the procedures for automatically delineating reservoir upstream catchments.

1. Using the MERIT Hydro flow directions and GeoDAR dam locations to drive the outlet relocation algorithm, resulting the raw full catchment of each reservoir (using the watershed .exe).
2. Clearing the holes to remove topology errors across full catchments using QGIS 3.24.
3. Checking all full catchments and removing/modifying unrealistic or incorrectly catchments. Most of these incorrectly catchments are assigned to small reservoirs located near the confluences of rivers of different sizes. See the example below where the reservoir "2844" is assigned to a large catchment of the mainstream (dark) rather than a small catchment of the tributary. We remove these small reservoirs that are assigned by a large catchment considering three aspects. Firstly, these reservoirs are relatively small, with a median size of 0.06 km^2 and 63% of them are smaller than 0.01 km^2. Secondly, the reservoirs have little regulation impacts and are typically removed from the literature (see CAMELS datasets). Thirdly, no rivers intersect the reservoirs, even the latest small rivers provided by Merit-Hydro, which means that the delineated catchment area is extremely small.
4. Generating intermediate catchments by removing the overlapping areas of upstream reservoirs from the full catchment of the current reservoir using QGIS 3.24.
5. Fixing the invalid geometry of intermediate catchments by eliminating geometry errors.

Based on the literature, and our discussion – cross validation (See main text Section 3.2), verifying the reliability of our delineated catchments.



Example.