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Dataset of Georeferenced Dams in South America (DDSA)

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Abstract. Dams and their reservoirs generate major impacts on society and the environment. In general, its relevance relies on facilitating the management of water resources for anthropogenic purposes, however, dams could also generate many potential adverse impacts related to safety, ecology or biodiversity. These factors, and the additional effects that climate change could cause in these infrastructures and their surrounding environment, highlight the importance of dams and the necessity for their continuous monitoring and study. There are several studies examining dams both at regional and global scale, however, those that include the South America region focus mainly on the most renowned basins (primarily the Amazon basin), most likely due to the lack of records on the rest of the basins of the region. For this reason, a consistent database of georeferenced dams located in South America is presented: Dataset of georeferenced dams in South America DDSA. It contains 1,010 entries of dams with a combined reservoir volume of 1,017 cubic kilometres and it is presented in form of a list describing a total of 24 attributes that include the dams name, characteristics, purposes and georeferenced location. Also, hydrological and additional information on the dam's catchments is also included: catchment area, mean precipitation, mean near-surface temperature, mean potential evapotranspiration, mean runoff, population and equipped area for irrigation. Information was obtained from public records, governments records, existing international databases and from extensive internet research. Each register was validated individually and geolocated using public access online map browsers and then, hydrological and additional information was derived from a hydrological model computed using the Hydrosheds dataset. With this database, we expect to contribute the development of new research in this region. The database is publicly available in https://doi.org/10.5281/zenodo.3885280 (Paredes-Beltran et al., 2020).

1 Introduction

Dams and their reservoirs provide continuous water supply for different anthropogenic necessities such as electric generation, water supply, irrigation, livestock or flood control. This becomes crucial in areas where there is a shortage of water resources either by seasonality or due to the increasing effects of climate change. However, in many cases these projects are controversial due to some associated negative impacts like the modification of stream systems, variation of ecological flows, alteration of biodiversity or due to the human resettlements these projects could generate.

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In general, these structures cause major impacts and changes wherever these are implemented, which in return makes them relevant for research. Usually, dams are studied for various reasons and using different approaches, for example, studies that asses or propose improvements on construction methods for dams (Ladd, 1992; Noorzaei et al., 2006; Xu et al., 2012), examine improvements on monitoring the structural health or safety of the dam (Gabriel-Martin et al., 2017; Li et al., 2004; Sjödahl et al., 2008) or evaluate their behaviour during seismic or failure events (Alonso et al., 2005; Zabala and Alonso, 2011). Reservoirs associated with dams are also relevant, for instance, by examining the effects, impacts and management alternatives of sediments fluxes (Dai and Liu, 2013; Kondolf et al., 2014). Usually, these studies require knowing a minimum set of characteristics of the dam, including their location and in most of the cases, need to be included into hydrological models.

The influence and effects of dams on their surrounding environments is also relevant for research. For instance, the impacts caused by dams and reservoirs on water supply (Biemans et al., 2011; Bouwer, 2000; Khalkheili and Zamani, 2009), the potential effects of climate change on altered river networks (Döll et al., 2009; Nilsson et al., 2005), the prospective scenarios that climate change could cause on irrigation water (Chavez-Jimenez et al., 2015; Elliott et al., 2014; Garrote et al., 2015), the repercussions of dams on water resources and biodiversity (Bejarano et al., 2017; Liermann et al., 2012; Vörösmarty et al., 2010) or the hydrological alterations caused by dams and reservoirs (Batalla and Go, 2004; Ibàñez and Prat, 1996).

In South America, relevant studies about dams at a full regional scale are rather scarce and usually focus on aquatic biodiversity conservation (Barletta et al., 2010; Reis et al., 2016) or river segmentation (Castello et al., 2013; Fearnside, 2001; Latrubesse et al., 2017; Roberto et al., 2009) and in most of the cases their conclusions highlight that potential negative effects of dams are low to moderate. However, these studies generally present two important limitations when trying to reach a full region scale: first, these focus only on the most relevant or renowned basins such as the Amazon, Parana - El Plata or Orinoco, and second, these only consider a limited amount of dam records.

There are several published dam databases that include information from South America. The largest and most recognized database is the World Register of Dams published by the International Commission on Large Dams (ICOLD, 2020) and reports 1,922 dams entries for South America; nonetheless, this database is not georeferenced which limits its use. AQUASTAT database was presented by (FAO, 2015) but it has not been updated since 2015 and for South America only reports 344 entries of georeferenced dams. Finally, another relevant database is the GRanD database (Lehner et al., 2011) which has been updated for the year 2019 and accounts for 343 geolocated dam entries for South America.

Here, we present an extensive and revised database with 1,010 registers of dams in South America, including information on their identification, the dam main characteristics, the dam purposes and their spatial location. Also, it includes hydrological and additional information derived from the HYDROSHEDS dataset (Lehner et al., 2008a): catchment area, mean near surface temperature, mean precipitation and mean potential evapotranspiration from the Climatic Research Unit (CRU) time-series dataset (Harris et al., 2020), mean runoff from the University of New Hampshire Global Runoff Data Centre (GRDC) composite runoff field (Fekete et al., 2002), population data from the Global Rural-urban Mapping Project (GRUMP) (Center for International Earth Science Information Network CIESIN et al., 2011) and equipped area for irrigation from the Global Map of Irrigated Area dataset (Siebert et al., 2005). This database has been developed to provide researchers additional information

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on dams in this region, with the expectation to further promote research either on a local, regional or global scale in any of the fields described.

This database is publicly available free for use in https://doi.org/10.5281/zenodo.3885280 (Paredes-Beltran et al., 2020).

2 Data description

2.1 Study Area

The study area is the continent of South America and includes Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, French Guyana, Paraguay, Peru, Suriname, Uruguay and Venezuela. A total of 1,010 catchments were considered which drain an area of approximately 5’283,000 square kilometres and discharge their waters to both the Pacific Ocean and the Atlantic Ocean; also, many of these catchments belong to some of the most emblematic rivers of the region such as the Amazon, the Parana - Rio de la Plata or the Orinoco River which drain water from several countries. Within each of this catchments, necessary observations were made to accurately locate dams with their respective reservoirs.

The study area is diverse and full of contrasts due to its unique geography; for example, the Andes mountains are a continuously seismic region that covers the entire west coast of the continent, the Amazon rainforest in the central part of the continent, large semiarid plains in the southeast and also the Atacama desert, which is a region of extreme aridity in the southwest. To the north of the Andes we have the presence of large glaciers that mostly drain east to form several rivers, including some of the largest in the world such as the Amazon and the Paraná - Rio de la Plata in the south and the Orinoco river in the north. On the east coast of the continent, exist humid mountain formations that extend from Venezuela to northern Brazil. The climate on the continent is varied mainly due to its size and topography, but also due to its wind patterns and ocean currents. Around the equator, climate can be considered mainly as tropical and humid with large amounts of rain, which decreases while moving further north and south of the equator, where different weather patterns are find. In the southern part of the continent, the humid winds of the Pacific Ocean provide rain to several areas in the coast of Chile, this winds are blocked due to the Andes mountains, which causes low precipitation around the year in the Patagonia region in the southeast. The climate within the Andes mountains are characterized as dry and cold, which covers the highest mountains with snow all year round. The driest region in the continent is the Atacama Desert due to its almost zero humidity, and its located in the north of Chile and the south of Peru. There are also important climate phenomena in South America, for example "El Niño", which greatly increases precipitation at the northwest area of the continent and have been occurred between periods of two to seven years.

2.2 Data sources

2.2.1 Compilation of preliminary information

A preliminary compilation of data regarding dams and reservoirs in the continent was first carried out to serve as a basis prior to the creation of this database. For this, two types of bibliographic sources were used: first, dams and reservoirs information

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from currently published databases, and second, records available about dams, reservoirs and water resources, from governments and other official sources. In the first case, we used two well-known open access databases of dams and reservoirs: The GRanD (http://globaldamwatch.org/grand/, last access: 23 May 2020) database and the AQUASTAT (http://www.fao.org/aquastat/es/databases/dams/, last access: 23 May 2020) database. It should be noted that although the WORLD REGISTER OF DAMS published by ICOLD is often considered to be the most comprehensive database on dams and reservoirs, is not open access nor has georeferenced entries, which ultimately led to discard it from this study. In the second case, it was noted that many governments keep up-to-date and comprehensive records of their water resources including dams and reservoirs. However, there were cases in which official information is not available. Table 1 details the public sources from which most of the information was obtained for each of the countries.

2.2.2 Geolocation of entries

To geolocate each dam record we used public access online map browsers such as: Google Earth (https://earth.google.com/web/, last access: 23 May 2020), Bing Maps (https://www.bing.com/maps, last access: 23 May 2020) and Open Street Maps (https://www.openstreetmap.org/#map, last access: 23 May 2020). Although these browsers do not provide us with the analytical capabilities of Geographic Information Systems (GIS) files and programs, these products are operative when visually searching for geographic locations and landmarks, as well as providing data that is often up to date. The coordinates in this database are described in decimal degrees using the WGS84 reference coordinate system.

2.2.3 Hydrosheds

To perform the analysis of the dam catchments, the HydroSHEDS (Hydrological data and maps based on SHuttle Elevation Derivatives at multiple Scales) dataset was used. This product allows users access to consistent hydrographic information on a regional scale at a resolution of 15 arc seconds and was derived primarily from the Shuttle Radar Topography Mission (SRTM). The dataset information was obtained from the public site (https://www.hydrosheds.org/downloads, last access: 23 May 2020) in raster format and for this project we utilized 3 layers: void-free elevation, drainage direction and flow accumulation.

2.2.4 Climatic Research Unit (CRU TS 4.03) time-series dataset

Mean monthly temperature, precipitation and potential evapotranspiration data was derived from the Climatic Research Unit (CRU TS 4.03) time-series dataset which is hosted by the UK's National Center for Atmospheric Science (NCAS) and produced by the University of East Anglia's Climatic Research Unit (CRU). The data in this dataset is provided in a resolution of 0.5 degrees by 0.5 degrees grid and completely covers the South America continent from 1901 to 2018. This product is derived from periodic interpolation of data from a network of meteorological stations. For this database we used the current 4.03 version, which is provided by the Center for Environmental Data Analysis (CEDA) website (https://crudata.uea.ac.uk/cru/data/hrg/#current, last access: 23 May 2020), in a NetCDF format.

2.2.5 University of New Hampshire Global Runoff Data Centre (GRDC) composite runoff field

Runoff data was obtained from the University of New Hampshire Global Runoff Data Center (GRDC) composite runoff field, which is a product developed by the Water Systems Analysis Group (WSAG) at CSRC at the University of New Hampshire (UNH). The GRDC is a dataset that combines observed river discharge information with climate-driven water balance models in order to develop consistent composite runoff fields. The method applied in this product uses selected gauging stations data archives to a simulated topological network and compares them with outputs from water balance model (WBM) simulation performed by the authors. The data in this dataset is provided in a resolution of 0.5 degrees by 0.5 degrees in ASCII formats and was obtained from the product public site (http://www.compositerunoff.sr.unh.edu/, last access: 23 May 2020).

2.2.6 Population data from the Global Rural-urban Mapping Project (GRUMP)

The estimated population data for each of the dams catchment was derived from the Global Rural-Urban Mapping Project (GRUMP) provided by the Socioeconomic Data and Applications Center (SEDAC), which offers different georeferenced population datasets at continental, regional and national scales. The data was obtained from the products public site (https://sedac.ciesin.columbia.edu/data/collection/grump-v1, last access: 23 May 2020) in ASCII format in a 30 arc second resolution.

2.2.7 Equipped Area for Irrigation from the Global Map of Irrigated Area dataset

The equipped areas for irrigation for each dam catchment was extracted from the Global Map of Irrigated Areas dataset provided by the Food and Agriculture Organization of the United Nations and it was developed by combining sub-national irrigation statistics with geospatial information. This dataset is presented in a resolution of 0.5 degrees and it is presented in ASCII-grid formats. The files were obtained from the products public site (http://www.fao.org/aquastat/en/geospatial-information/global-maps-irrigated-areas/, last access: 23 May 2020).

2.3 Data processing

2.3.1 Dams and reservoirs characteristics

After an extensive review of available information about dams and reservoirs in South America, we determined that georeferenced information about dams in this continent is limited. It is one of the main reasons why we aimed to develop a new database that includes all the current consistent information available. This database is the result of the compilation and treatment of information available from existing public documents from national governments, existing open databases and other web sources. For this, we proceeded in three stages: first, we collected all the available published information on dams and reservoirs; second, we compared and validated this data with the existing information available from local and national governments; and finally, we determined the geolocation of each point. This information has been processed and we carried out an

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extensive data validation and error checking, elimination of duplicate or inaccurate entries and completion of information where possible.

First, we researched for the most relevant databases of dams and reservoirs available and found three consistent results: The World Register of Dams from ICOLD, the GRanD database and the AQUASTAT database of dams. After the initial inspection, we discarded the ICOLD database because even though it is widely considered as the largest database on dams with over 57,985 entries worldwide and 1,922 dam entries in South America, it is not georeferenced nor it is an open-access database, which limits later validation of our results. Then, we inspected the AQUASTAT database (which has not been updated since 2015) and collects detailed information of more than 14,000 dams; nonetheless, in the case of South America the list consists of 1,964 dams of which only 344 entries are georeferenced. Finally, we examined the GRanD database which presents 7,320 entries, however, only 343 of those entries correspond to South America.

Once initial information was collected from open-access databases to assemble our preliminary list, we examined public records available from local and national governments in each country. We compiled them in order to compare this data with our preliminary list, data collected from governments and other public sources is available in different formats and in most cases required different types of approximation and treatment to obtain results. Each dam record was compared individually and in the case of correspondence it was accepted, in the case of countries where we did not find available public reports, we compared and verified our preliminary records with information available on the internet, emphasizing on dams with a reservoir capacity greater than one cubic hectometre, although some records with smaller volume of reservoir were included as these were able to be verified in a reliable manner. Finally, a supplementary search in the internet was performed in order to exclude gaps, mismatches or errors.

Finally, the geolocation of the dams was assessed individually for each record. First, we verified and corrected the data of the preliminary list and then we carried out a second geolocation assessment for our final database using public access online map browsers like Google maps, Bing maps and Open Street maps. In most cases, it was necessary to carry out extensive examinations for each dam since there were cases in which the names of the dams were not sufficient reference to locate them, thus, it was necessary to use additional references such as the nearby cities or villages, the reservoirs names, rivers names, or secondary or alternative names of the dams.

2.3.2 Hydrological information of the reservoir's catchments

Hydrological information for each dam is also provided in this database: estimated catchment area, mean monthly precipitation, mean monthly near-surface temperature and mean monthly potential evapotranspiration from the Climatic Research Unit (CRU TS 4.03) time-series dataset and mean monthly runoff from the University of New Hampshire Global Runoff Data Centre (GRDC) composite runoff field.

Once the database dams were verified and accepted, each location point was aligned according to the Hydrosheds raster dataset (Lehner et al., 2008b) in order to determine the dams catchments. First, flow direction of each of the model raster cells was

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computed by applying the "D8" algorithm. Second, the ridge cells between catchments were identified to delineate them. Finally, the catchment areas were calculated by counting the contributing above cells to each dam.

Surface climate variables are commonly used inputs in studies like agriculture, ecology and biodiversity. For this reason, precipitation, near-surface temperature and potential evapotranspiration mean monthly values from 1901 to 2018 are included for each dam catchment in this database. This data was derived from the Climatic Research Unit (CRU TS 4.03) time-series dataset (Harris et al., 2014) which is a commonly used high-resolution gridded set and has been compared favourably with other climatic datasets (Beck et al., 2017; Jacob et al., 2007). First, datasets for each variable were downloaded in netCDF formats for monthly periods from 1901 to 2018. Then, these files were converted, resampled and aligned into raster formats in order to match the dam's catchment model. Finally, a statistical analysis for each variable was calculated in order to derive mean monthly values of precipitation, near-surface temperature and potential evapotranspiration for each dam catchment.

A basic requirement in the assessment of water resource systems is monthly runoff data. For this, the mean monthly runoff data for each dam was also included using the University of New Hampshire and Global Runoff Data Centre (UNH/GRDC) Composite Runoff field v1.0 (Fekete et al., 2002) that is often regarded as the best available runoff dataset for large scale models (Gonzàlez-Zeas et al., 2012; Lv et al., 2018), which combines river discharge measurements and water balance models and provides gridded high-resolution annual and monthly mean runoff series. The runoff dataset for South America was downloaded from the data product site in ASCII-grid formats, then, the file was converted, resampled and aligned in order to match the dam's catchment model. Finally, a statistical analysis was applied in order to derive mean monthly runoff data for each dam catchment.

2.3.3 Additional information

Additional information for each dam is also provided: population within each dam catchment, estimated from the Global Rural-urban Mapping Project (GRUMP) and irrigation area within each dam catchment, based on the Global Map of Irrigated Area dataset.

Demographic data is usually a necessary input for studies that include urban or rural information on water resources assessments. Population for each dam catchment is included on the database and was derived from the Global Rural-urban Mapping Project (GRUMP) (Center for International Earth Science Information Network CIESIN et al., 2011), which is often used as baseline data for studies that require large-scale maps of urban or rural areas (Florczyk et al., 2020; Mcdonald et al., 2011) and is based on polygons defined by the extent of the night-time light imagery and approximated urban extents from ground-based settlement points. Population data was downloaded from the data product site in ASCII-grid formats. The file was converted, resampled and aligned in order to match the dam's catchment model, and a statistical analysis was applied in order to account the corresponding population for each dam catchment.

Finally, hydrological data for irrigation is also included. Equiped area for irrigation for each dam catchment was obtained from the Global Map of Irrigation Areas dataset (Siebert et al., 2005) which is a global scale dataset of irrigated areas based on cartographic information and FAO statistics and is often used to provide valuable information about irrigation in hydrological

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models (Wisser et al., 2008). Equipped area for irrigation data was downloaded from the data product site in ASCII-grid formats, then, the file was converted, resampled and aligned in order to match the dam's catchment model. A statistical analysis was performed to account the equipped area for irrigation for each dam catchment.

3 Results

3.1 Dams and Reservoirs

Once the review, refinement and processing of the data concluded, a total of 1,010 dam entries were accepted for our database, this represents a noticeable progress in the identification and geolocation of dams in the region and thus, enables the opportunity for new research that allows a more precise understanding of the water resources systems in the region. After a comparison with other databases, 376 entries were similar to the AQUASTAT and GrAND databases; however, they were included in our database since the 1,010 entries were inspected and verified following the same procedure described in previous sections. Additionally, this database increases dam entries not only as a total regional number but also increases the number of entries per country, which means that with this database we also expect to contribute for new research in study areas that have not been considered to date due to the absence of reliable information. Table 2 details the entries in our database for each country considered in this study, including a comparison with the AQUASTAT and GrAND databases.

Table 3 describes the 24 variables processed and accepted for this database. The estimated total reservoir volume of this database is 1,017 cubic kilometres and the largest reservoir belongs to the "Guri" dam in Venezuela with an estimated volume of 135 cubic kilometres.

3.2 Hydrological Information

The model derived from the Hydrosheds dataset allowed us to determine the catchment areas of this database, which were necessary to carry out the subsequent hydrological calculations. The accumulated area of the dam's catchments is approximately 14'855,192 square kilometres with an average catchment of 18,385 square kilometres, the largest catchment belongs to "Jirau" dam in Brazil with an estimated area of 962,732 square kilometres. Table 4 describes the variables processed for the hydrological information and included in this database. Our results highlight the great influence and importance of the Amazon rainforest in the continent since most of the highest records are observed in this region. In the case of temperature, the highest annual record is located in the catchment of the "Malhada Vermelha" dam in Brazil with a temperature of 27.89 degrees Celsius. In the case of precipitation, the highest annual record is in the catchment of the "Petit Sout" dam in French Guiana with a total of 3,035.74 millimetres per year. The highest potential evapotranspiration record is documented for the catchment of the "Pilões" dam in Brazil with 1,713.32 millimetres per year. Finally, in the case of runoff, the highest annual recorded value is located in the catchment of the "Billings" dam, located in Brazil with 2,961.70 millimetres per year. On the other hand, the lowest records are observed mostly in the southern part of the continent in the Andes mountains, with the lowest temperature being recorded in July in the catchment of the "El Yeso" dam in Chile with -3.36 degrees Celsius, the lowest annual

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precipitation occurs in the catchment of the "Austral" dam in Chile with 5.21 millimetres per year, and the lowest potential evapotranspiration is recorded in the catchment of the "Huelehueico" dam in Chile with 0.72 millimetres per day in June. Figure 2 details the annual average values for each of the hydrological variables included in this database.

3.3 Additional Information

Table 4 describes the variables processed for the additional information provided in this database. Both, in the case of population and equipped areas for irrigation, the highest values belong to “Yacyreta” catchment dam with more than 55 million people in the case of population and more than 930,000 square kilometres of equipped areas for irrigation. Figure 3 depicts the values for population an equipped area for irrigation for all catchments in the database.

5 Data limitations

The information provided in this database cannot be considered error free since it has been prepared using the information available at the time of its elaboration. It should also be noted that although our database was created independently, through an individual investigation and based primarily on reports and documents available from each of the countries in the region, the database may include attributes of dams that are also reported by other existing dam databases such as ICOLD, AQUASTAT and GRaND.

6 Data availability

The Database of Georeferenced Dams of South America (DDSA) is available in https://doi.org/10.5281/zenodo.3885280 (Paredes-Beltran et al., 2020).

7 Summary

The database of georeferenced dams in South America (DDSA) has been developed to contribute to the improvement of water resources management in the region. The provision of reliable, high-resolution available data on dams and reservoirs will contribute in the assessment of freshwater ecosystems and communities both for present and future scenarios in this region, which to this date, have been restricted to a limited number of catchments due to the absence of available information, and thus, contributing to generate more informed decision-making processes in order to safeguard the future sustainability of the communities in this region.

The 1,010 entries of dams present a total of 24 attributes. Each record has been included in the list after an individual review and its position has been determined considering public digital terrain models. In addition, the database also provides mean monthly hydrological information. With this increased spatial coverage and attributes information, this database could be used as a baseline for further studies that address relevant issues regarding hydrology, ecology and people in the region. Also, with the inclusion of data for all the countries in the continent we also expect to contribute to an in-depth comprehension on the hydrological and environmental dynamics for the entire continent, and encouraging the generation of knowledge in areas that have not been considered in past studies.

Finally, the data presented in this databased is largely based on open-access information available to date, therefore, it is necessary to expect for further contributions and monitoring in order to provide new data inputs and updates that may keep this database relevant to the public.

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Author contributions.

BEPB: Conceptualization, Investigation, Data curation, Validation, Software, Formal analysis, Methodology, Writing - original draft, Writing - review & editing. ASW: Conceptualization, Formal analysis, Funding acquisition, Methodology, Validation, Writing - review & editing, Supervision, Resources. LG: Formal analysis, Software, Funding acquisition, Validation, Writing - review & editing, Supervision, Resources, Project administration.

Competing interests.

The authors declare that they have no conflict of interest.

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Table 1: Available public data records of dams per country

COUNTRY	AVAILABLE PUBLIC INFORMATION	NUMBER OF ENTRIES	GEOREFERENCED INFORMATION
ARGENTINA	Inventario de Presas y Centrales Hidroeléctricas de la República Argentina (Subsecretaría de Recursos Hídricos, 2010)	31	No
BOLIVIA	Inventario Nacional de Presas Bolivia (Programa de Desarrollo Agropecuario Sustentable (PROAGRO), 2010)	287	Yes
BRAZIL	Mapa Interativo das Barragens Cadastradas (Agencia Nacional de Aguas, 2019)	18,880	Yes
CHILE	Directorio de Presas (Comite Nacional Chileno de Grandes Presas, 2019)	107	No
COLOMBIA	Other *(Internet pages)* (ISAGEN, 2020)	-	No
ECUADOR	Other *(Internet pages)* (ElecAustro, 2020; Hidroabanico, n.d.; Instituto Nacional de Pesca, 2020)	-	No
FRENCH GUYANA	Not available	-	-
GUYANA	Not available	-	-
PARAGUAY	Not available	-	-
PERÚ	Inventario de Presas en el Perú (Autoridad Nacional del Agua, 2016)	743	Yes
SURINAME	Not available	-	-
URUGUAY	Not available	-	-
VENEZUELA	Other *(Internet pages)* (Instituto Nacional de Estadistica, 2020)	-	No

Table 2: Number of new dam entries per country

COUNTRY	DDSA	OTHER DATABASES			NEW ENTRIES PER COUNTRY
		GRAND	AQUASTAT	SIMILAR ENTRIES TO DDSA*	
ARGENTINA	107	35	0	35	72
BOLIVIA	66	3	56	57	9
BRAZIL	507	182	0	182	325
CHILE	73	10	0	10	63
COLOMBIA	58	24	16	33	25
ECUADOR	21	6	2	6	15
FRENCH GUYANA	2	1	1	1	1
GUYANA	3	0	0	0	3
PARAGUAY	4	2	0	2	2
PERÚ	73	13	0	13	60
SURIMANE	1	1	0	1	0
URUGUAY	13	4	0	4	9
VENEZUELA	82	32	0	32	50
TOTAL	**1010**	**313**	**75**	**376**	**634**

* In some cases, AQUASTAT and GRanD entries were duplicated, so they were considered as a single entry

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Table 3: List of variables processed for dams and reservoirs

VARIABLE	UNIT	DESCRIPTION
ID		Unique Id number for each dam
NAME OF THE DAM		Name of the dam
OTHER NAME		Alternative names given to the dam (aliases, former names)
DECIMAL DEGREE LATITUDE	Decimal Degrees	Latitude coordinate of point location of the dam.
DECIMAL DEGREE LONGITUDE	Decimal Degrees	Longitude coordinate of point location of the dam
HEIGHT	m	Height of the dam above foundation expressed in meters
LENGTH	m	Length of the dam measured at the crest expressed in meters
RESERVOIR CAPACITY	MCM	Capacity of the reservoir expressed in million cubic meters
RESERVOIR AREA	sq. km.	Area of the reservoir expressed in square kilometres
RESERVOIR NAME		Name of the reservoir or water body, if different from the dam name
RIVER		Name of the river in which the dam is located
INTERNATIONAL		Indicates if the dams or reservoirs lie within more than one country
YEAR OF COMPLETION		Reported year of completion of the dam
FLOOD CONTROL		Use of the dam for Flood Control
IRRIGATION		Use of the dam for Irrigation
HYDROELECTRICITY		Use of the dam for Hydroelectricity
NAVIGATION		Use of the dam for Navigation
RECREATION		Use of the dam for Recreation
WATER SUPPLY		Use of the dam for Water Supply
OTHER USE		Use of the dam for other purposes
COUNTRY		Name of country
NEAREST TOWN		Name of the nearest town or city to the dam location
STATE / PROVINCE		Additional information about the location of the dam
NOTE		Specific comments of importance

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Table 4: List of hydrological and additional information processed in this study

VARIABLE	UNIT	DESCRIPTION
CATCHMENT AREA	sq. km.	Calculated catchment area per dam expressed in square kilometres
NEAR SURFACE TEMPERATURE	°C	Calculated monthly average near surface temperature value derived from the Climatic Research Unit (CRU TS 4.03) time-series dataset per each dam catchment expressed in degrees Celsius
PRECIPITATION	mm/month	Calculated monthly average precipitation value derived from the Climatic Research Unit (CRU TS 4.03) time-series dataset per each dam catchment expressed in millimetres per month
POTENTIAL EVAPOTRANSPIRATION	mm/day	Calculated monthly average potential evapotranspiration value calculated using the Pen-Monteith method derived from the Climatic Research Unit (CRU TS 4.03) time-series dataset per each dam catchment expressed in millimetres per day
GRDC	mm/month	Calculated monthly average monthly runoff derived from the University of New Hampshire Global Runoff Data Centre (GRDC) composite runoff field per each dam catchment expressed in millimetres per month
POPULATION	People	Calculated population data from the Global Rural-urban Mapping Project (GRUMP) per dam catchment
IRRIGATION	sq. km.	Calculated irrigation area from the Global Map of Irrigated Area dataset per dam catchment expressed in square kilometres

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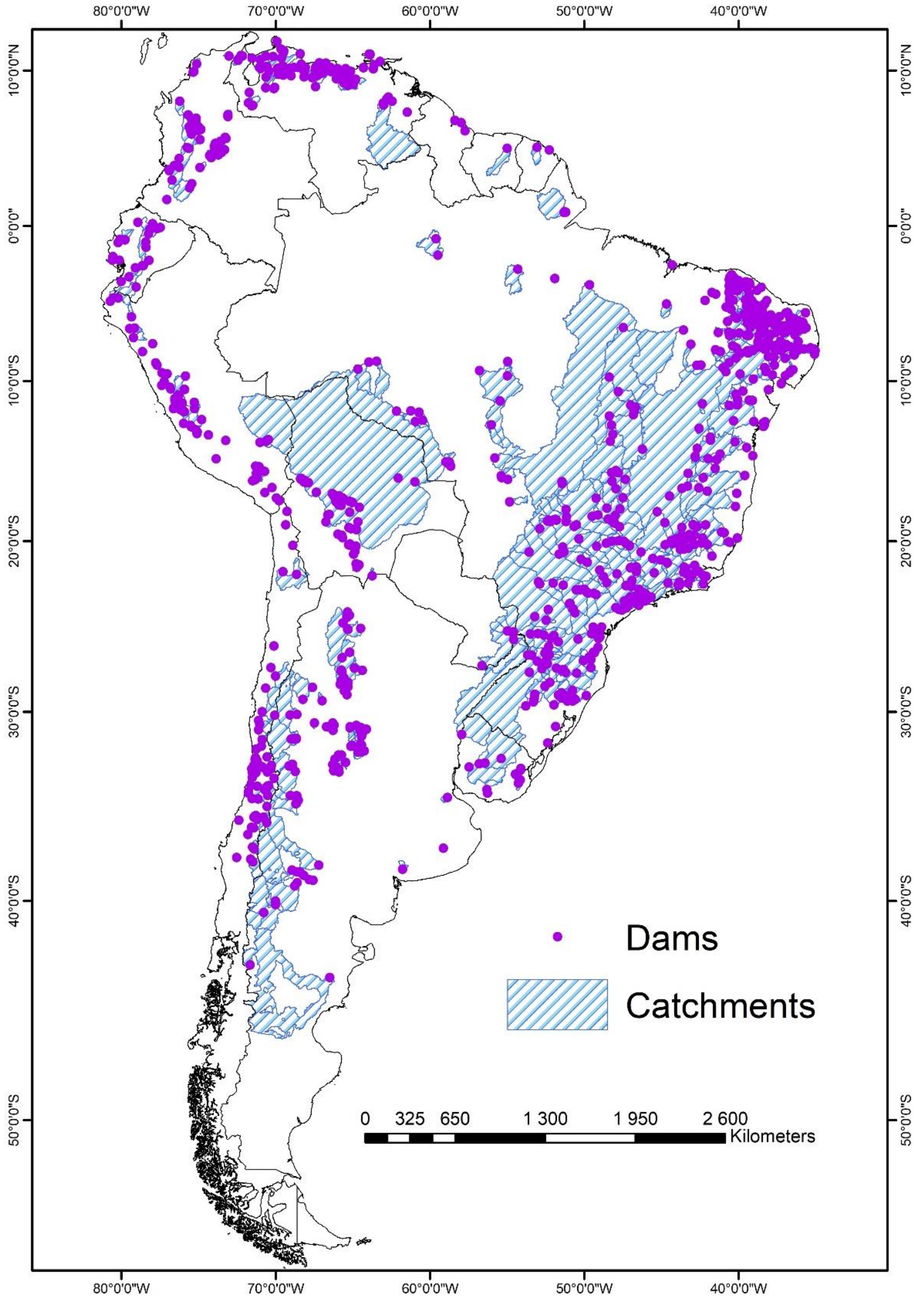

445 **Figure 1.** Dataset of Georeferenced Dams in South America (DDSA)

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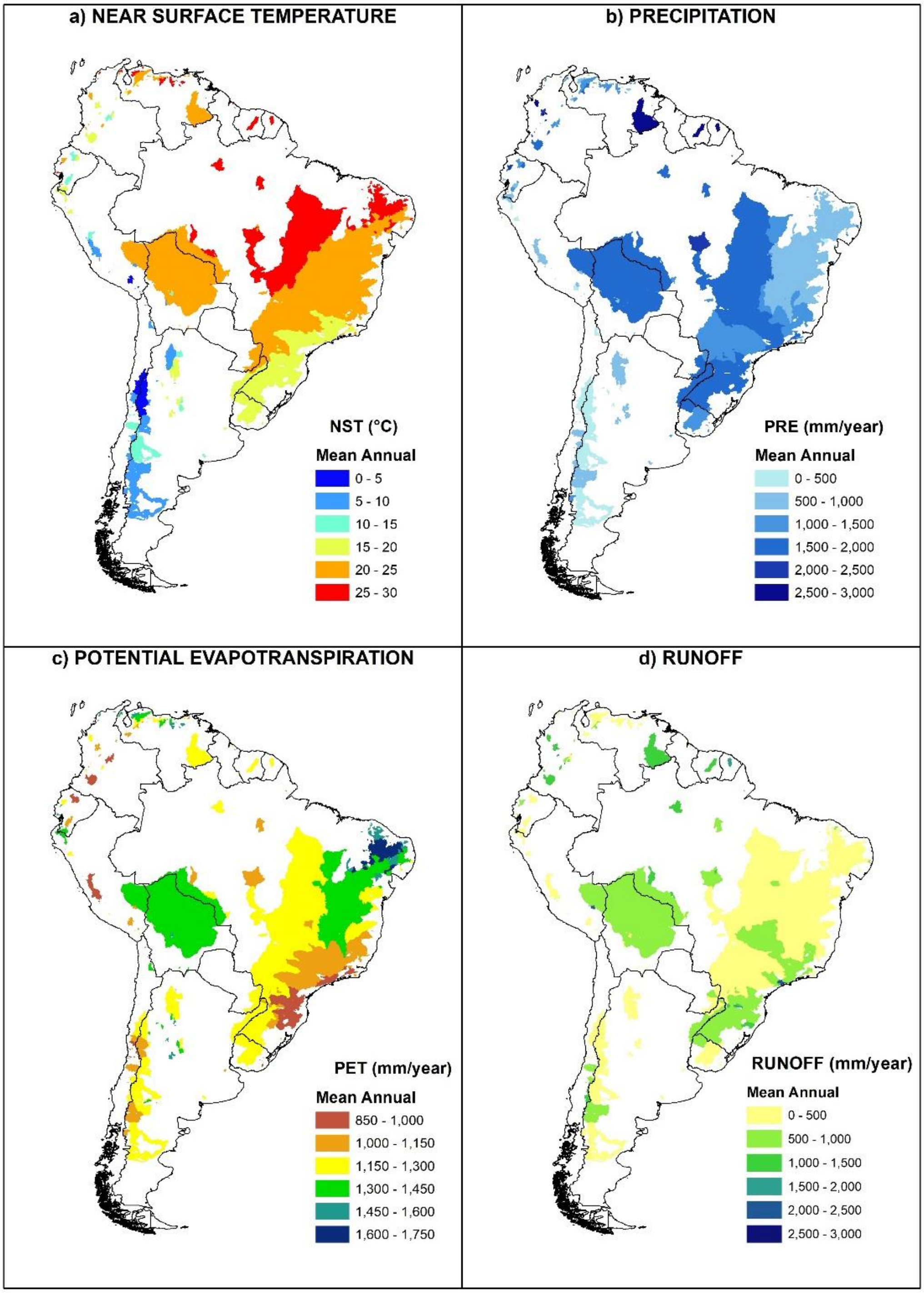

Figure 2. Hydrological Information processed for this study: **a)** Near Surface Temperature**, b)** Precipitation**, c)** Potential Evapotranspiration**, d)** Runoff

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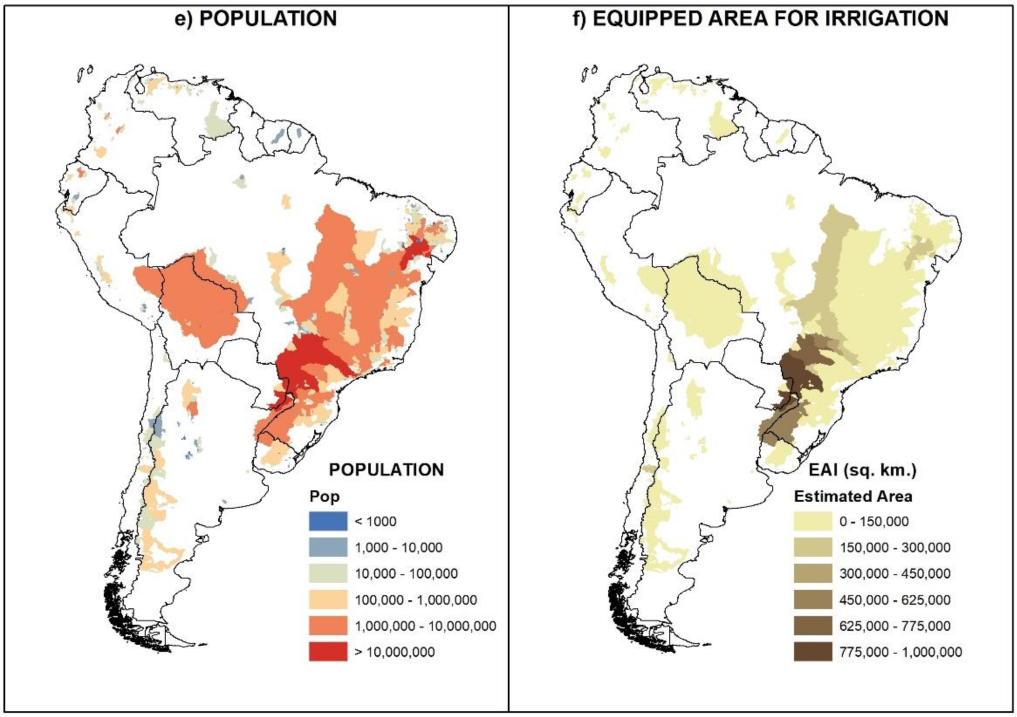

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Figure 3. Additional Information processed for this study: **e)** Population**, f)** Equipped Area for Irrigation