Global Reservoir and Dam (GRanD) Database

Technical Documentation

Version 1.3

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1. Overview and background of GRanD

Despite established recognition of the many critical environmental and social tradeoffs associated with dams and reservoirs, global data sets describing their characteristics and geographical distribution have been largely incomplete. The most comprehensive global dam database, the World Register of Dams, is compiled by the International Commission on Large Dams (ICOLD) and currently lists more than 58,000 records of large dams and their attributes (ICOLD 1998-2018). However, this inventory is not georeferenced, which limits its utility for many applications. Several researchers and organizations have created their own global and regional spatial data sets of dams and reservoirs (see Table 1), mostly by identifying the largest of them and compiling attribute information from various sources including national archives and the internet. These databases vary widely in their number of records, the quality of attribute data, and their spatial resolution, ranging from coarse coordinates to lumped national or regional assignments.

The development of the original Global Reservoir and Dam Database (GRanD v1.1) was an initiative of the Global Water System Project (GWSP), a joint project of the Earth System Science Partnership (ESSP). GRanD v1.1 aimed to harmonize and collate existing dam and reservoir data sets into a single, geographically explicit and reliable database for the scientific community, resulting in georeferencing the location of 6862 dam locations with a cumulative storage capacity of 6197 km^3 (Figure 1). Published in 2011 (Lehner et al. 2011), the database has since served as the basis for hundreds of regional and global studies related to rivers and related systems.

GRanD v1.2 was not produced as a standalone product but is embedded in the global HydroLAKES v1.0 database of natural lakes and human-made reservoirs (Messager et al. 2016). Reservoirs from GRanD v1.1 were identified and referenced in HydroLAKES v1.0 and many reservoir polygons were updated with improved data, in particular those in Canada and in regions north of 60°N latitude.

GRanD v1.3 is the latest update of GRanD, unifying and extending v1.1 and 1.2. GRanD v1.3 integrates some changes and corrections to the attribute information of GRanD v1.1 dams, combines them with the updated reservoir polygons of GRanD v1.2 reservoirs, and adds a series of new dams and reservoirs > 0.1 km^3 that were primarily built between the years 2000 and 2016. GRanD v1.3 expands the GRanD database by 458 new dam locations, bringing the total to 7320 dams, and adds a total reservoir storage capacity of 667 km^3 (Figure 1).

GRanD v1.3 is freely available for non-commercial use at:

globaldamwatch.org (Global Dam Watch)

GRanD v1.1 is freely available for non-commercial use at:

globaldamwatch.org (Global Dam Watch) – or –
sedac.ciesin.columbia.edu/pfs/grand.html (SEDAC at CIESIN)

This Technical Documentation first outlines the development of GRanD v1.1 (section 2), followed by a description of the updates made in GRanD v1.3 (section 3) and general data specifications, acknowledgements, and references (sections 4-6).

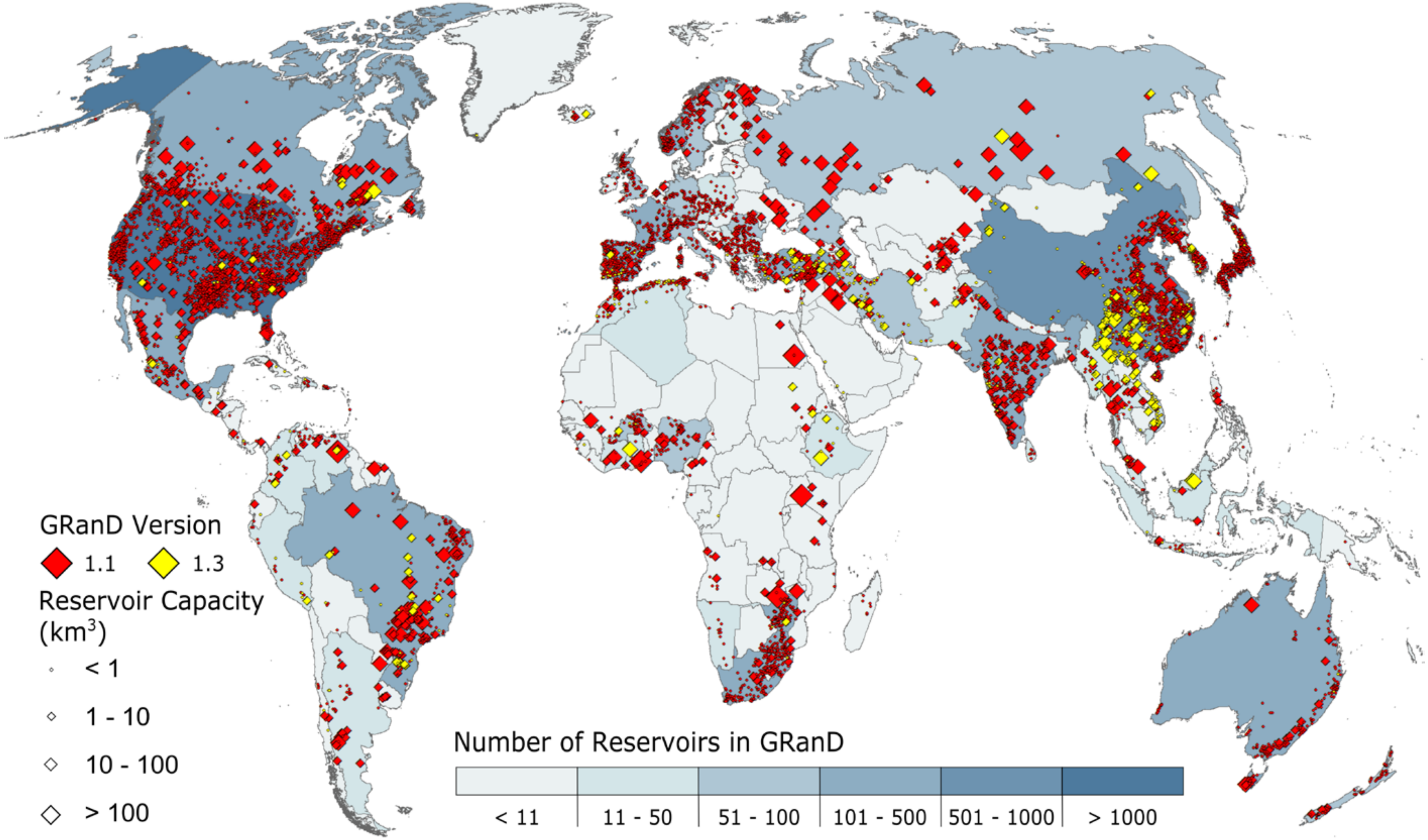

Figure 1: Global distribution (by country) of large reservoirs in GRanD database.

2. Development of GRanD v1.1

2.1 Objective of GRanD version 1.1

The development of GRanD, starting with version 1.1, primarily aimed at compiling available reservoir and dam information; correcting it through extensive cross-validation, error checking, and identification of duplicate records, attribute conflicts, or mismatches; and completing missing information from a multitude of sources or statistical approaches. The dams were geospatially referenced and assigned to polygons depicting reservoir outlines at high spatial resolution. While the main focus was to include all reservoirs with a storage capacity of more than 0.1 km^3, some smaller reservoirs were added if data were available. GRanD v1.1 compiled 6862 records of reservoirs and their associated dams (Figure 1), with a cumulative storage capacity of 6197 km^3.

The development of GRanD v1.1 was coordinated by the Global Water System Project (GWSP), Bonn, Germany, and was executed in partnership and collaboration between members of the following institutions and organizations: Department of Geography, McGill University, Montreal, QC, Canada; The CUNY Environmental Cross-Roads Initiative, City University of New York, NY, USA; University of New Hampshire, Durham, NH, USA; University of Washington, Seattle, WA, USA; The Nature Conservancy, Arlington, VA, USA; Conservation Science Program, World Wildlife Fund, Washington, DC, USA; European Environment Agency, Copenhagen, Denmark; Food and Agriculture Organization of the United Nations, Rome, Italy; University of Yamanashi, Japan; University of Greifswald, Germany; University of Frankfurt, Germany; and Department of Ecology and Environmental Science, Umeå University, Sweden.

2.2 Procedures and uncertainties in compiling GRanD v1.1

Table 1 shows the individual data sets that were contributed by 11 of the participating institutions to serve as the foundational sources of constructing the GRanD v1.1 database. The various data sets showed different characteristics regarding their resolution, accuracy, comprehensiveness, and the type of attributes—mostly due to the different objectives and needs when assembling them. An intrinsic problem of all existing dam and reservoir data sets is that they may be related to the same original sources, thus errors in their associated attribute tables may have been propagated and are difficult to identify. Also, while no criterion for minimum height of dams was applied in the generation of GRanD v1.1, many of the source data sets used a threshold of 15 m in their original collections, introducing a bias in the initial selection towards higher dams.

Most sources provided spatial information of some kind, such as point coordinates, yet often at very coarse resolution (e.g., 0.5 degree grid cells). Only the data of GLWD and the University of Yamanashi explicitly included polygons of the impounded reservoirs. To consolidate the spatial representation and improve accuracy, the locations of all dams of the source data sets were verified, updated, and/or newly georeferenced in a Geographic Information System (GIS)—guided by maps, atlases and online resources (including Google Earth). Each dam (with a few exceptions, see below) was assigned to a polygon that depicts the reservoir surface. Most polygons used for this procedure were provided by the SRTM Water Body Database (SWBD), a near-global, public mapping product created at 30 m pixel resolution from remote sensing imagery (Slater et al. 2006). Additional reservoir outlines were added from various alternative sources, or digitized from scratch. It should be noted that reservoir outlines are typically subject to strong seasonal fluctuations; and as most GRanD v1.1 polygons are originally depicted from remote sensing imagery (i.e. a snapshot in time) they may reflect a low-fill or dry-season state with significantly smaller than maximum area.

Table 1: *Institutions that participated in the development of the GRanD database (in alphabetical order), their provided data sets, focus of contribution, and number of provided records. It should be noted that these collections, in turn, used underlying information from a much wider range of sources, including a variety of regional and national inventories and gazetteers, ICOLD's World Register of Dams (ICOLD 1998-2009), and a large variety of publications, monographs and maps.*

Institution	*Provided data and focus of contribution*	*# of independent data records* [a]
European Environment Agency, Denmark	Provided point and attribute data for Europe[b]	3,793 (Europe)
Food and Agriculture Organization of the United Nations (FAO)	Provided point and attribute data for Africa (AQUASTAT[c])	1,138 (Africa)
McGill University, Canada	Provided GLWD[d]; updated/improved data for Australia[e] and globally; final global data consolidation of GRanD	1,226 (GLWD); 846 (Australia)
The Nature Conservancy (TNC), USA	Updated/improved data for South America	149 (South America)
University of Frankfurt, Germany	Co-author of GLWD[d]; updated/improved data for China	568 (China)
University of Greifswald, Germany	Provided global point and attribute data; updated/improved data for Europe	8,157 (global, excluding USA, China, Africa); 4,230 (Europe)
University of Kassel, Germany	Co-author of GLWD[d]	-
University of New Hampshire, USA	Provided global point and attribute data; updated/improved data for North America (incl. NID[f])	1,897 (USA); 236 (Canada); 226 (Mexico)
Umeå University, Sweden	Provided global point and attribute data	5,575 (global, excluding North America, Europe, Russia)
University of Yamanashi, Japan	Provided global point, polygon, and attribute data; updated/improved data for Japan	15,073 points[g], 4,648 polygons (global); 560 (Japan)
World Wildlife Fund (WWF), USA	Co-author of GLWD[d]; updated/improved data for Asia	215 (Asia)

[a] while data sets have been compiled independently by research groups, many records are based on similar or the same original sources and may thus contain duplicates

[b] the European Environment Agency is in the process of systematically geo-referencing dams in its working area; for the compilation of GRanD their draft version of 2007 was used; since then ~5,000 large dams have been located in Europe and are publicly available as components of EEA's river and catchment GIS (ECRINS)

[c] AQUASTAT geo-referenced database on African dams, version of 2007; FAO (2010)

[d] Global Lakes and Wetland Database; Lehner and Döll (2004)

[e] original data provided by Commonwealth of Australia (Geoscience Australia 2004)

[f] US National Inventory of Dams (Graf et al. 1999)

[g] mostly compiled from other sources and national databases; including many small dams (e.g. ~8,000 dams in USA from NID[f])

Linking the original records of all source data sets to the same polygon features provided a consistent avenue for detecting errors such as nomenclature mismatches and conflicting attribute data. The procedure entailed two important advantages: Firstly, it allowed for a cross-validation of the provided information as the attributes of the different sources could be evaluated against each other and tested regarding their physical feasibility, e.g. by comparing the reported reservoir surface area with the calculated polygon area. Secondly, the linkage to unique polygons introduced a clear relationship between reservoirs and associated dam(s), which supported the identification and elimination of duplicates. Duplicity was evident in the source data due to various reasons, including cases where multiple dams form one reservoir; a dam is updated in time at the same location; or the same dam or reservoir is erroneously listed several times, often with inconsistent names and attributes. The problem of duplicity may have caused previous dam and reservoir databases to overestimate total global storage volumes and numbers.

Records with suspicious information were flagged and individually verified. For example, if the ratio between reported storage capacity and reservoir surface area—i.e. the average depth of a reservoir—resulted in a value of less than 1 m or more than the reported dam height (or more than 300 m if no dam height was available), the record was flagged as unreasonable. All flagged records were then inspected and erroneous values were corrected using auxiliary information from literature or online sources. Many inconsistencies were caused by typos and order-of-magnitude errors, such as mistyped volumes by a factor of 1000; or by unit mismatches (e.g. feet vs. meters). Finally, data gaps were filled by comparing and merging attributes from different databases, by consulting and adding independent sources of information, or by applying statistical approaches (see section 4.2 below). If inconsistencies, uncertainties, or data gaps remained, the 'Quality' index of the record was lowered accordingly (see attribute list in section 4.4).

Not all data sources provided a clear distinction on whether their attribute data refer strictly to a physical 'dam' or to the impounded 'reservoir' behind it, or both. For example, some original data on 'volume' may refer to the dam wall (i.e. concrete or other building material) instead of the reservoir's storage capacity. Also, in many cases the dam name is different from the reservoir name, such as Lake Mead, the largest reservoir of the US, being impounded by the Hoover Dam. Another uncertainty is caused by the lack of one-to-one relationships between dams and reservoirs: some dams, such as barrages, diversions, or run-of-the-river hydropower stations, may not form reservoirs; some impoundments may have multiple dams (e.g. main and saddle dams); and some reservoirs have no dams at all, such as water stored in natural or artificial depressions. These ambiguities compound the importance of knowing to which object data refer. To ensure maximum clarity, GRanD explicitly distinguishes between dam (point) and reservoir (polygon) information.

3. Development of GRanD v1.3

3.1 Compiling new dam and reservoir records

New dams and reservoirs in GRanD v1.3 were mostly derived from data sources available online. These included national repositories, the UNFCCC's Clean Development Mechanism project registry, some privately maintained databases like Roller Compacted Concrete Dams, and for validation purposes information listed by the International Commission on Large Dams (ICOLD). Attribute information for each dam and reservoir was compiled and cross-referenced using multiple sources to verify veracity and identify conflicts. Links to source material is included in each record for reference where available. All dams were assigned a geospatial point location using a combination of published coordinate information and web-based satellite and reference maps (including Google Maps, Yandex, and Global Surface Water Explorer).

3.2 Procedures for creating GRanD v1.3 reservoir polygons

Most new reservoir polygons added in the update of GRanD v1.3 were delineated from the surface water maps produced by the Joint Research Center (JRC) of the European Commission from Landsat imagery at 30 m resolution for the period 1984-2015 (Pekel et al. 2016). The gridded JRC maps showing 'maximum surface water extent' were first modified with boundary cleaning filters to consolidate connected water surfaces and to slightly smooth the shorelines, and were then converted to polygons. After reservoirs were created for all dam points, the polygons were manually inspected and, if necessary, corrected by comparing them to ESRI basemaps, Google maps, Yandex maps, Mapbox, JRC surface water change maps, NASA Worldview imagery, and any auxiliary documents pertaining to each dam. Where necessary, these images were georeferenced and used to manually delineate or correct reservoir shorelines. In particular, adjustments were made to isolate the reservoir from inflowing rivers, or to merge multiple pools which were falsely separated by a bridge or through a narrow channel. In places where a reservoir was not completed or filled by the year 2015 and thus not visible in the JRC surface water data, the reservoir polygons were manually delineated based on ESRI basemaps and/or other georeferenced imagery. Some remaining dam points had no visible reservoir in any available imagery; they were annotated as not yet filled (and "no polygon") in the point version of GRanD, and no associated reservoir record exists in the polygon version.

3.3 Other updates in GRanD v1.3

Besides adding 458 new dam locations and associated reservoir polygons, some erroneous records from GRanD v1.1 were updated. Also, the original polygons of GRanD v1.1 were replaced with those from the HydroLAKES v1.0 database of natural lakes and human-made reservoirs (Messager et al. 2016), which particularly improved polygon quality for reservoirs in Canada and in regions north of 60°N latitude. The outlet points of the HydroLAKES polygons were used as proxies for the associated dam locations, leading to some alterations as compared to GRanD v1.1. Finally, the storage capacities of reservoirs without reported information were recalculated using the new polygon areas and Equations 1 and 2 (see section 4.2), and elevation, discharge and Degree of Regulation records were revised based on updated source data (see section 4.1 and Table 2).

4. Data specifications

4.1 Dam and reservoir attribute derivation

Each record in GRanD—as identified by a unique ID—typically represents a combined 'reservoir-and-dam object' and is defined by both a polygon and a point location (see also section 4.3 on data formats). The point represents the location of the 'main' dam; if there are multiple dams forming a single reservoir, these are defined in the attribute table of that same record. Objects can also be defined by a point only; this may indicate a missing polygon, or an independent dam without a reservoir, such as a run-of-the-river hydropower station. While the main focus in the development of GRanD was to include all reservoirs with a storage capacity of more than 0.1 km^3, some smaller reservoirs were added if data were available. In instances where natural lakes are regulated by dams, such as Africa's Lake Victoria, only the added storage volume was considered. Finally, some dams were included due to their importance, such as India's Farakka Barrage which diverts water from the Ganges River, even if they don't create a traditional reservoir.

In order to identify a reservoir's dam location, reservoir polygons were combined with HydroSHEDS, a global digital river network (Lehner et al. 2008). Visual inspections showed very good spatial correspondence between GRanD v1.3 and HydroSHEDS. Using HydroSHEDS at a grid resolution of 15 arc-seconds (~500 m), the main dam—or equivalently the reservoir outlet—was defined as the pixel with the highest flow accumulation within each polygon. The linkage of GRanD with the multiple information layers of the HydroSHEDS database also allowed for the derivation of additional attributes, in particular catchment area and long-term average discharge. The discharge values provided by HydroSHEDS are based on downscaled runoff estimates from the global hydrological model WaterGAP (Döll et al. 2003) for the period 1971-2000 and were also used to calculate the 'Degree of Regulation (DOR)' index for every dam (see Table 2).

Note that the values for catchment area, discharge, and DOR were updated in GRanD v1.3 using slightly modified polygon outlines and associated dam locations as compared to GRanD v1.1, as well as a revised version of the WaterGAP discharge estimates. Results can thus differ from original values in GRanD v1.1. Also, elevation values in GRanD v1.3 were derived from the newer EarthEnv-DEM90 digital elevation model (Robinson et al. 2014).

4.2 Estimating missing reservoir volumes

In the course of constructing GRanD v1.1, two equations were derived and applied in v1.1 and v1.3 in order to complete missing reservoir volumes:

$$V = 0.678\ (A \cdot h)^{0.9229} \qquad \text{(Eq. 1)}$$

$$V = 30.684\ A^{0.9578} \qquad \text{(Eq. 2)}$$

where V = reservoir volume in 10^6 m^3; A = reservoir area in km^2; and h = dam height in m. Equation 1 was used to estimate missing reservoir volumes if both area and dam height were available (R^2 = 0.92); Equation 2 was used if only the reservoir area was available (R^2 = 0.80). Both equations were determined by a statistical regression analysis of 5824 reservoirs of the GRanD v1.1 database which were selected based on the completeness and reliability of their data. For this selection, the following records were excluded from the total of 6862 GRanD v1.1 records:

- records without polygon
- records without reported dam height
- records without reported capacity
- records flagged as "planned", "under construction", or "destroyed"
- records with "poor" or "unreliable" data quality
- records flagged as lake control dams

Note that Equations 1 and 2 were derived by relating reported capacities to measured polygon areas. As the polygons in many cases depict a status below full capacity, the equations may not be appropriate to estimate capacities from maximum reported areas.

4.3 File and data formats

Both versions of GRanD (v1.1 and v1.3) consist of two separate GIS layers:

- 'GRanD_dams_v1_x' is a point layer containing all dams and their attribute information
- 'GRanD_reservoirs_v1_x' is a polygon layer containing all corresponding reservoir outlines and their attribute information

Each dam point lies within its corresponding reservoir polygon, thus the features and attributes of both layers can be spatially joined based on their location. Additionally, both attribute tables carry the same unique identification number (column 'Grand_id'). Version 1.1 of GranD contains 6862 dam points and 6824 reservoir polygons (38 dams do not have an associated reservoir, including some diversion barrages and planned dams). Version 1.3 of GranD contains 7320 dam points and 7250 reservoir polygons (70 dams do not have an associated reservoir, including some diversion barrages and dams under construction).

Both the point and polygon layer are provided in ESRI® shapefile format. Each shapefile consists of five core files (.dbf, .sbn, .sbx, .shp, .shx). Projection information is provided in an ASCII text file (.prj); both shapefiles are in geographic (latitude/longitude) projection, referenced to datum WGS84.

NOTE: Users without GIS software or without the option to interpret shapefiles may import the file 'HydroLAKES_points_v10.dbf' (in dBASE IV format) in most spreadsheet programs. This file contains all GRanD attribute information, and the dam locations can be plotted using the provided x/y-coordinates.

4.4 Attribute table of shapefiles "GRanD_dams_v1_3" and "GRanD_reservoirs_v1_3"

Due to the high variability in the information pertaining to the primary data sources, decisions had to be made regarding which attributes to include in the construction of GRanD. These decisions were largely driven by requests from different disciplines interested in the application of the GRanD database, including hydrology, geomorphology, ecology, biogeochemistry, biodiversity conservation, and water resources management. Depending on data availability, some attribute fields are fully populated, while others remain incomplete.

***Table 2:** Attributes provided in the point layer (GRanD_dams) and in the polygon layer (GRanD_reservoirs) of the GRanD database. Note that the 'number of occurrences' refers only to the point layer (7320 dams) and may be slightly lower for the polygon layer (7250 polygons).*

Column title	*Description*	*Number of occurrences*
Grand_id	Unique ID for each dam and associated reservoir; IDs correspond between dam (point) and reservoir (polygon) layers of the GRanD database; IDs up to 6862 refer to dams and reservoirs included in version 1.1; IDs 6863 and above were added in version 1.3	7320
Res_name	Name of reservoir or lake (i.e. impounded water body)	2062
Dam_name	Name of dam structure	7304
Alt_name	Alternative name of reservoir or dam (including different spelling, different language)	810
River	Name of impounded river	6962
Alt_river	Alternative name of impounded river (including different spelling, different language)	710
Main_basin	Name of main basin	2527
Sub_basin	Name of sub-basin	708
Near_city	Name of nearest city	4553
Alt_city	Alternative name of nearest city (including different spelling, different language)	302
Admin_unit	Name of administrative unit	5685
Sec_admin	Secondary administrative unit (indicating dams or reservoirs that lie within or are associated with multiple administrative units)	69
Country	Name of country	7320
Sec_cntry	Secondary country (indicating international dams or reservoirs that lie within or are associated with multiple countries)	50
Year	Year in which the dam was built (not further specified: year of construction; year of completion; year of commissioning; year of refurbishment/update; etc.)	6954
Alt_year	Alternative year of construction (not further specified: may indicate a multi-year construction phase, an update, or a secondary dam construction)	439
Rem_year	Year in which the dam was removed, replaced, subsumed, or destroyed; see also column 'Timeline' below (Note: this column was introduced in GRanD v1.3)	10
Dam_hgt_m	Height of dam in meters	6839
Alt_hgt_m	Alternative height of dam (may indicate update or secondary dam construction)	365
Dam_len_m	Length of dam in meters	5882
Alt_len_m	Alternative length of dam (may indicate update or secondary dam construction)	209
Area_skm	Representative surface area of reservoir in square kilometers; consolidated from other 'Area' columns in the following order of priority: 'Area_poly' over 'Area_rep' over 'Area_max' over 'Area_min'; exceptions apply if value in 'Area_poly' column seems unreliable; see also notes below	7293
Area_poly	Surface area of associated reservoir polygon in square kilometers	7255
Area_rep	Most reliable reported surface area of reservoir in square kilometers	5207
Area_max	Maximum value of other reported surface areas in square kilometers	158
Area_min	Minimum value of other reported surface areas in square kilometers	289
Cap_mcm	Representative maximum storage capacity of reservoir in million cubic meters; consolidated from other 'Cap' columns in the following order of priority: 'Cap_max' over 'Cap_rep' over 'Cap_min'; exceptions apply if value in 'Cap_max' column seems unreliable or rounded; see also notes below	7312
Cap_max	Reported 'maximum storage capacity' in million cubic meters; see notes below	2412
Cap_rep	Reported 'storage capacity' in million cubic meters; value may refer to different types of storage capacity; see notes below	6780
Cap_min	Minimum value of other reported storage capacities in million cubic meters	1168
Depth_m	Average depth of reservoir in meters; calculated as ratio between storage capacity ('Cap_mcm') and surface area ('Area_skm'); values that are somewhat higher than the dam height ('Dam_hgt_m') may still be reasonable, e.g. if the storage capacity refers to the maximum volume yet the reservoir polygon represents a low-fill status; values capped at 1000 indicate exceedingly high values which may be due to inconsistencies in the data	7293

Column title	*Description*	*Number of occurrences*
Dis_avg_ls	Long-term (1971-2000) average discharge at dam location in liters per second; value derived from HydroSHEDS flow routing scheme combined with WaterGAP runoff estimates (Döll et al. 2003) at 15s resolution at point location of dam	7320
Dor_pc	Degree of Regulation (DOR) in percent; equivalent to “residence time” of water in the reservoir; calculated as ratio between storage capacity (‘Cap_mcm’) and total annual flow (derived from ‘Dis_avg_ls’); values capped at 10,000 indicate exceedingly high values, which may be due to inconsistencies in the data and/or incorrect allocation to the river network and the associated discharges	7312
Elev_masl	Elevation of reservoir surface in meters above sea level; value derived from EarthEnv-DEM90 data set (Robinson et al. 2014) at 15s resolution at point location of dam	7320
Catch_skm	Area of upstream catchment draining into the reservoir in square kilometers; value derived from HydroSHEDS at 15s resolution at point location of dam	7320
Catch_rep	Reported area of upstream catchment draining into reservoir in square kilometers	2016
Data_info	Supporting information on certain data issues: ‘Capacity from statistics’ = capacity derived from Eq. 1 or Eq. 2 ‘Capacity estimated’ = capacity estimated from other available information	57
Use_irri	Used for irrigation (‘Main’; ‘Major’; or ‘Sec’ = Secondary use)	2370
Use_elec	Used for hydroelectricity production (‘Main’; ‘Major’; or ‘Sec’ = Secondary use)	2492
Use_supp	Used for water supply (‘Main’; ‘Major’; or ‘Sec’ = Secondary use)	1646
Use_fcon	Used for flood control (‘Main’; ‘Major’; or ‘Sec’ = Secondary use)	1194
Use_recr	Used for recreation (‘Main’; ‘Major’; or ‘Sec’ = Secondary use)	1143
Use_navi	Used for navigation (‘Main’; ‘Major’; or ‘Sec’ = Secondary use)	288
Use_fish	Used for fisheries (‘Main’; ‘Major’; or ‘Sec’ = Secondary use)	212
Use_pcon	Used for pollution control (‘Main’; ‘Major’; or ‘Sec’ = Secondary use)	51
Use_live	Used for livestock water supply (‘Main’; ‘Major’; or ‘Sec’ = Secondary use)	49
Use_othr	Used for other purposes (‘Main’; ‘Major’; or ‘Sec’ = Secondary use); other purposes may include new or a mix of the above purposes	499
Main_use	Main purpose of reservoir: Irrigation; Hydroelectricity; Water supply; Flood control; Recreation; Navigation; Fisheries; Pollution control; Livestock; or Other	5759
Lake_ctrl	Indicates whether a reservoir has been built at the location of an existing natural lake using a lake control structure; currently this column only contains limited entries; ‘Yes’ = lake control structure raises original lake level; ‘Enlarged’ = lake control structure enlarged the original lake surface area; ‘Maybe’ = not sure, but data seems to indicate a lake control structure	119
Multi_dams	Indicates whether there is more than one dam associated with this reservoir (e.g. main and saddle dam); if ‘Yes’, then columns ‘Alt_year’, ‘Alt_hgt_m’, and ‘Alt_len_m’ refer to the secondary dam	215
Timeline	Indicates whether the status of a dam has changed or will change over time: ‘Destroyed’ (dam got destroyed or failed) ‘Modified’ (dam was modified from an earlier status, e.g. raised, expanded, refurbished, but the earlier status is not individually recorded in GRanD) ‘Planned’ (dam is planned to be built in the future) ‘Removed’ (dam record and point are retained but the dam itself has been removed and not replaced) ‘Replaced’ (dam record and point are retained in data set but the dam itself has been replaced; the new dam is recorded as a new GRanD point) ‘Subsumed’ (dam record and point are retained but the dam and reservoir themselves were subsumed by larger infrastructure constructed further downstream; the old reservoir polygon has been removed in version 1.3 and the new dam and reservoir are recorded as a new GRanD point and polygon) ‘Under construction’ (dam is currently under construction)	86
Comments	Comments	782
Url	URL of related website	2001

Column title	*Description*	*Number of occurrences*
Quality	Quality index: 1: Verified (location and data have been verified) 2: Good (location and data seem good but have not all been verified) 3: Fair (some data discrepancies; missing data; or uncertainties) 4: Poor (significant data discrepancies of various kinds that indicate errors) 5: Unreliable (severe data discrepancies without reasonable explanation)	7320
Editor	Final data editor: 'McGill' = McGill University (BL = B. Lehner; PB = P. Beames) 'UNH' = University of New Hampshire	7320
Long_dd	Longitude of point location of dam in decimal degrees; the point location is only an approximation of the actual dam location	7320
Lat_dd	Latitude of point location of dam in decimal degrees; the point location is only an approximation of the actual dam location	7320
Poly_src	Original source of reservoir polygon: 'CanVec' = Canadian hydrographic dataset (Natural Resources Canada 2013) 'ECRINS' = European Catchments and Rivers Network System (EEA 2012) 'GLWD' = Global Lakes and Wetlands Database (Lehner and Döll 2004) 'JRC' = polygon digitized from European Commission Joint Research Centre's surface water layer (Pekel et al. 2016) 'JRC modified' = initial polygon digitized from JRC surface water layer and then modified by McGill University 'McGill' = polygon digitized from scratch or majorly modified by McGill University 'NHD' = US National Hydrography Dataset (US Geological Survey 2013) 'SWBD' = SRTM Water Body Database (Slater et al. 2006) 'UY' = polygon provided by University of Yamanashi 'Other' = other sources, including remote sensing imagery and GIS repositories 'No polygon' = no polygon available	7320

Notes:

- The columns 'Area_skm' and 'Cap_mcm' have been created to provide a "most representative" estimate of reservoir surface area and maximum capacity. The values were derived from other columns following the rules as indicated in Table 2. It should be noted, however, that the source values may not correctly refer to "maximum", "normal", or "minimum" conditions as this distinction was often not available in the original sources (see also next note).
- In most original data sources, no distinction was made between "maximum capacity", "gross capacity", "normal capacity", "live capacity", or "minimum capacity"; or the distinction was not reliable. If an explicit, reliable distinction was available, the values were entered as 'Cap_max' (for maximum or gross capacity), 'Cap_rep' (for normal capacity) and 'Cap_min' (for live or minimum capacity). If no distinction was available and only one value was provided, it was entered as 'Cap_rep'. If no distinction was available and two values were provided, the most reasonable one was entered as 'Cap_rep', and the other one as 'Cap_max' or 'Cap_min' according to its size. If no distinction was available and more than two values were provided, they were sorted into 'Cap_max', 'Cap_rep', and 'Cap_min' according to their size. For all records of the United States, 'Cap_max' explicitly refers to "maximum capacity" and 'Cap_rep' explicitly refers to "normal capacity".
- Regarding the use/purpose of a reservoir: 'Main' refers to the primary purpose; 'Major' refers to a primary/important purpose, yet not the main one (note that the distinction between 'Main' and 'Major' may be arbitrary in some cases); 'Sec' refers to a secondary purpose.
- Missing numerical records are flagged with value "-99".

5. Acknowledgement, citation, disclaimer, and restrictions

5.1 Acknowledgement

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