



CAMELS-GB v2: hydrometeorological time series and landscape attributes for 671 catchments in Great Britain

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Abstract. Large-sample hydrological datasets containing data for tens to thousands of catchments are invaluable for hydrological process understanding and modelling. CAMELS (Catchment Attributes and MEteorology for Large-sample
 20 Studies) datasets provide hydro-meteorological timeseries, catchment attributes and catchment boundaries. Here, we present the second version of CAMELS-GB. CAMELS-GB v2 collates millions of observations from across Great Britain at hourly to monthly timescales, including quality-controlled daily river flows, catchment boundaries, and catchment characteristics from the UK National River Flow Archive. The new features include (1) extended daily hydro-meteorological timeseries from 1970- 2022 including meteorological timeseries from new observed climate datasets, (2) new hourly precipitation, river flow
 25 and level timeseries, (3) new groundwater level timeseries and attributes for 55 groundwater wells, and (4) new catchment attributes characterising changing land cover, peak flows and human influences. These data are provided for 671 catchments across Great Britain spanning a diverse range of geophysical characteristics and human influences. CAMELS-GB v2 represents a step change for environmental and modelling analyses across Great Britain, particularly for the characterisation of sub-daily hydrological processes, and is made available as an open dataset (Coxon et al., 2025; <https://doi.org/10.5285/9a46d428-958f-4ac1-86eb-94eee70c0955>).
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1 Introduction

Large-sample hydrological (LSH) datasets are invaluable for hydrological process understanding and modelling. LSH datasets provide data for tens to thousands of catchments over national (e.g. Australia, Fowler et al., 2021; Austria, Klingler et al., 2021; Brazil, Almagro et al., 2021; Chagas et al., 2020; Chile, Alvarez-Garretton et al., 2018 ; Great Britain, Coxon et al., 2020;



35 Haiti, Bathelemy et al., 2024; Iceland, Helgason and Nijssen, 2024; Spain, Senent-Aparicio et al., 2024; Sweden, Teutschbein,
2024; Switzerland, Höge et al., 2023; USA, Addor et al., 2017), continental (e.g. Europe, do Nascimento et al., 2024; North
America, Arsenault et al., 2020) and global (e.g. CARAVAN, Kratzert et al., 2023; Global Streamflow and Indices and
Metadata Archive; Do et al., 2018) scales. While the core data underpinning LSH datasets are streamflow data, LSH datasets
also often include meteorological timeseries, simulated timeseries from hydrological models, catchment boundaries and
40 catchment attributes at various spatial and temporal scales. This enables robust benchmarking of hydrological models across
a diverse range of catchments (e.g. David et al., 2022; Lees et al., 2021), improved understanding of hydrological processes
across environmental gradients (e.g. Addor et al., 2018; Coxon et al., 2024; McMillan et al., 2022), characterisation and
prediction of extreme events (e.g. Chagas et al., 2022b; Rasheed et al., 2024) and assessment of the impacts of climate and
land management on streamflow (e.g. Chagas et al., 2022a; Slater et al., 2024). Increasingly, LSH datasets have adopted FAIR
45 (findable, accessible, interoperable, and reusable) principles to ensure (1) the large-sample dataset and their source datasets are
open-access, and (2) the software tools used to create the large-sample hydrology datasets are open and accessible (Fowler et
al., 2025). This has enabled a growing community of LSH datasets, such as the CARAVAN dataset, which included data for
6830 catchments when published in 2023 (Kratzert et al., 2023) but now contains data for more than 20,000 catchments.

CAMELS (Catchment Attributes and MEteorology for Large-sample Studies) datasets are a family of large-sample hydrology
50 datasets that contain hydro-meteorological timeseries, catchment attributes and boundaries for large-samples of catchments
for specific countries or regions. CAMELS-GB v1 was the first large-sample, open access dataset for Great Britain (Coxon et
al., 2020; Coxon, 2020). It consists of hydro-meteorological catchment time series, catchment attributes (describing
topography, climate, hydrology, land cover, soils, hydrogeology, and human influences), and catchment boundaries for 671
catchments. It has been used to understand human impacts on river flows (Bloomfield et al., 2021; Coxon et al., 2024), analyse
55 the spatial sensitivity of river flooding to changes in climate and land cover (Slater et al., 2024), calibrate and evaluate
hydrological models (Kiraz et al., 2023) and to benchmark data-driven runoff models (Lees et al., 2021). It has also been
incorporated into global catchment datasets (Kratzert et al., 2023). While CAMELS-GB v1 is a valuable dataset, there are
important gaps in the current dataset. Firstly, it only contains daily hydro-meteorological timeseries, when sub-daily timeseries
are often needed for flood characterisation in small catchments across Great Britain. Secondly, it only contains static catchment
60 attributes (i.e. one snapshot of a geophysical property in time) which makes it challenging to use for trend analyses. Thirdly,
groundwater is an important resource in Great Britain, yet there are no timeseries available for groundwater levels in
CAMELS-GB v1.

This paper addresses these data needs by providing a new version of CAMELS-GB. CAMELS-GB v2 contains new datasets
including hourly hydro-meteorological timeseries, groundwater level timeseries, dynamic catchment attributes characterising
65 changes in land cover and static catchment attributes characterising groundwater timeseries and reservoirs. We also update the
existing data in CAMELS-GB to lengthen the daily hydro-meteorological timeseries and to include the latest rainfall and
potential evapotranspiration data for Great Britain. Key differences between the two versions of CAMELS-GB are summarised



in Table 1. CAMELS-GB v2 is open access and available on the Environmental Information Data Centre (EIDC). The remainder of the paper describes the changes between v1 and v2, a full description of any new data and advice for users of CAMELS-GB v2.

2 Catchment selection and boundaries

CAMELS-GB v2 contains data for the same 671 catchments as CAMELS-GB v1. These catchments were selected from the UK National River Flow Archive (NRFA) Service Level Agreement (SLA) network (see Dixon et al., 2013; Hannaford, 2004), excluding catchments from Northern Ireland (due to a lack of consistent climate and landscape datasets across the UK) and two gauges where no suitable catchment boundary could be derived. The SLA network ensures a core network of stations for long-term records that undergo additional quality control and validation on the NRFA (Dixon et al., 2013; Muchan and Dixon, 2014). The resulting 671 catchments span a diverse range of hydrological characteristics that represent rivers across GB.

As with CAMELS-GB v1, catchment boundaries are provided in CAMELS-GB v2 as shapefiles in the OSGB 1936 co-ordinate system (British National Grid). The catchment boundaries were derived using the same underlying data and method as for CAMELS-GB v1 (see Section 3 from Coxon et al, 2020 for more details) but updated to better reflect the accuracy of the stations' outlet locations, with minimal influence on the attributes of the final dataset. The catchment boundaries are mostly identical to those provided in CAMELS-GB v1; only two catchments have more than 1% difference in catchment area, with a maximum difference of 1.5%.

To calculate catchment areal averages for time series and catchment attributes, the exactextract Python package (Baston, 2025) is used to extract data from gridded datasets based on catchment boundary polygons. This tool computes catchment average values by accounting for grid cells that are only partially covered by a polygon. Precisely determining the fractional coverage of each grid cell within a catchment is especially important for small catchments, where coarse approximations can lead to significant differences in the extracted values.

3 Time Series Data

Daily and hourly hydro-meteorological timeseries are provided for 671 catchments, alongside daily and monthly groundwater level timeseries for 55 boreholes. This section describes the CAMELS-GB v2 timeseries in detail including the source datasets and differences between products.

3.1 Daily hydro-meteorological timeseries

Daily hydro-meteorological time series are provided for the 671 catchments (see Table 2). The daily time series data includes key hydro-meteorological variables (streamflow, rainfall, potential evapotranspiration and temperature) from 1st October 1970



– 30th September 2022 to provide a valuable, long-term dataset as input and evaluation data for hydrological models, trend analysis and characterisation of hydrological processes.

3.1.1 Daily meteorological timeseries

To provide consistency with CAMELS-GB v1, we derive the daily timeseries from the same underlying meteorological datasets; rainfall from CEH Gridded Estimates of Areal Rainfall dataset, potential evapotranspiration and temperature from the Climate hydrology and ecology research support system (CHESS). These datasets were selected due to their high spatial resolution (1 km²), long temporal coverage (>50 years) and basis on the UK climate monitoring network. However, these meteorological datasets are no longer consistently updated and do not cover the full time period required. Consequently, in CAMELS-GB v2 we also provide meteorological timeseries of catchment average rainfall, potential evapotranspiration and temperature from a new UK dataset of gridded climate observations (HadUK-Grid; Hollis et al., 2019) with a national comparison of the different products shown in Figure 1.

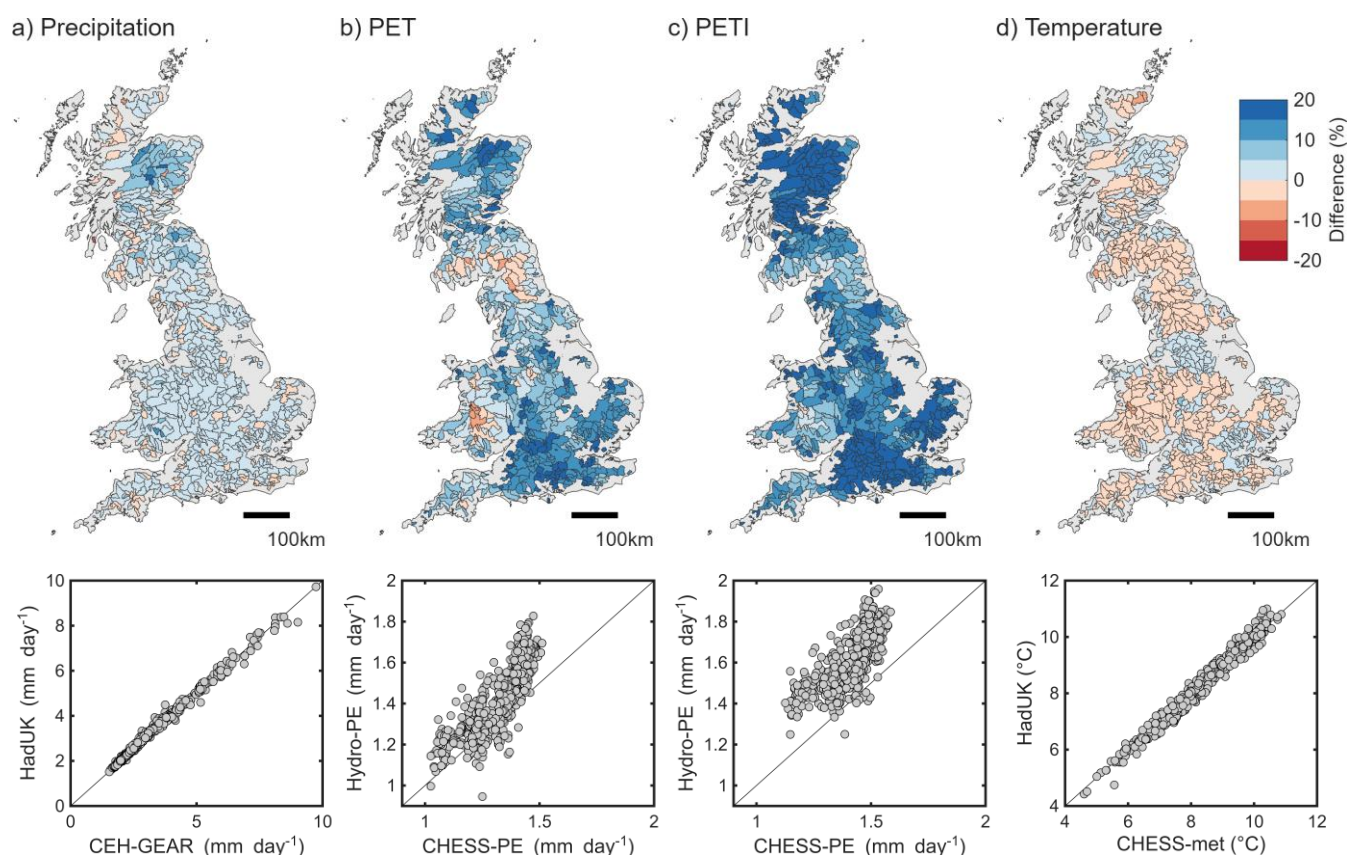


Figure 1. National comparison of mean daily a) rainfall (mm day⁻¹) between HadUK-Grid and CEH-GEAR, b) potential evapotranspiration (PET, mm day⁻¹) between Hydro-PE and CHESS-PE PET products, c) potential evapotranspiration with



110 interception (PETI, mm day⁻¹) between Hydro-PE and CHES-PE PETI products and d) temperature (degrees C) between
 HadUK-Grid and CHES-met. Mean daily averages calculated from 1st October 1970 – 30th September 2022 for the 671
 CAMELS-GB catchments. The blue colours indicate that the HadUK/Hydro-PE daily averages are higher than the CEH-
 GEAR/CHES datasets, while the red colours indicate that the HadUK/Hydro-PE daily averages are lower than the CEH-
 GEAR/CHES datasets, as a percentage of the CEH-GEAR/CHES datasets. Contains OS data © Crown Copyright and
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Daily rainfall timeseries were derived from two national products; the CEH Gridded Estimates of Areal Rainfall dataset (CEH-
 GEAR; Keller et al., 2015; Tanguy, 2021) and the HadUK-Grid dataset (Hollis et al., 2019). Both consist of 1 km² gridded
 estimates of daily rainfall and are based on quality-controlled precipitation data from the Met Office UK rain gauge network.
 However, the two datasets cover different time periods and the two datasets use different interpolation methods. CEH-GEAR
 120 covers 1890 – 2019 whereas HadUK-Grid rainfall is available from 1836 – 2023. The CEH-GEAR dataset uses natural
 neighbour to interpolate the data, whereas HadUK-Grid uses inverse-distance weighted interpolation to generate the daily
 rainfall grids. Given the similarities in their underlying datasets, the difference between the two rainfall products is small for
 most CAMELS-GB catchments (Figure 1a, S1). However, there can be differences of up to 20% in mean annual rainfall totals
 and larger differences in daily totals for individual catchments (Figure S2).

125 Daily temperature timeseries were derived from the Climate Hydrology and Ecology research Support System meteorology
 dataset (CHES-met; Robinson et al., 2017a) and the HadUK-Grid dataset (Hollis et al., 2019). CHES-met contains 1 km²
 gridded estimates of daily mean air temperature (K) from 1961-2019 derived from the Met Office Rainfall and Evaporation
 Calculation System (MORECS) dataset (Hough and Jones, 1997). MORECS is a 40 km gridded dataset of daily temperature
 derived from Met Office synoptic stations. For the temperature data in CHES-met, the MORECS temperature data was
 130 interpolated from 40 km resolution to 1km resolution using a bicubic spline and then the temperatures were adjusted to the
 elevation of each 1km square using the same lapse rate. HadUK-Grid contains 1km² gridded estimates of daily maximum and
 minimum air temperature (°C) from 1960-2023 derived by interpolating temperature observations from climate observing
 stations in the Met Office's Integrated Data Archive System (MIDAS). Daily mean temperatures have been calculated by
 averaging maximum air temperature on day D and minimum air temperature on day D+1 for each day. On average, the
 135 difference in mean daily temperature between the two products is relatively small (0.14°C; Figure 1d); however, differences
 can be larger for individual timesteps (Figure S1, S2).

Daily potential evapotranspiration (PET) timeseries were derived from the Climate Hydrology and Ecology research Support
 System Potential Evapotranspiration dataset (CHES-PE; Robinson et al., 2016) and the Hydro-PE HadUK-Grid dataset
 (Hydro-PE; Brown, 2022; Robinson et al., 2023). Both datasets consist of daily 1km² gridded estimates of potential-
 140 evapotranspiration for Great Britain calculated using the Penman-Monteith equation for well-watered grass. They also both
 provide daily potential evapotranspiration with (PETI) and without (PET) an interception correction. Core differences between
 the datasets are that the PET datasets cover different time periods; 1969-2022 for Hydro-PE and 1961-2019 for CHES-PE.
 They also provide different PET estimates, with the Hydro-PE HadUK-Grid dataset providing higher mean annual estimates



of PET (on average 0.1 mm day^{-1} higher across the CAMELS-GB catchments) and PETI (on average 0.2 mm day^{-1} higher across
145 the CAMELS-GB catchments) for most CAMELS-GB catchments (Figure 1b, c). This is due to differences in the underlying
data and methodologies used to derive the PET estimates. CHESS-PE is derived from CHESS-met variables (Robinson et al.,
2017a) that have been downscaled from the Met Office Rainfall and Evaporation Calculation System (MORECS) dataset
(Hough and Jones, 1997), whereas Hydro-PE is derived from HadUK-Grid meteorological data (Hollis et al., 2019). Wind
speeds are higher and specific humidity is lower in the HadUK-Grid dataset, and many of the variables in the Hydro-PE
150 HadUK-Grid dataset have been temporally downscaled from monthly to daily using a simple smooth interpolation (for a full
discussion of the differences, see Section 5.1 in Robinson et al., 2023). This leads to different estimates of daily PET and PETI
between the different datasets across all CAMELS-GB catchments (Figures S1 and S2).



As the meteorological timeseries from HadUK-Grid covers the full time period, we use these data to derive the climate catchment attributes described in Section 5.2.

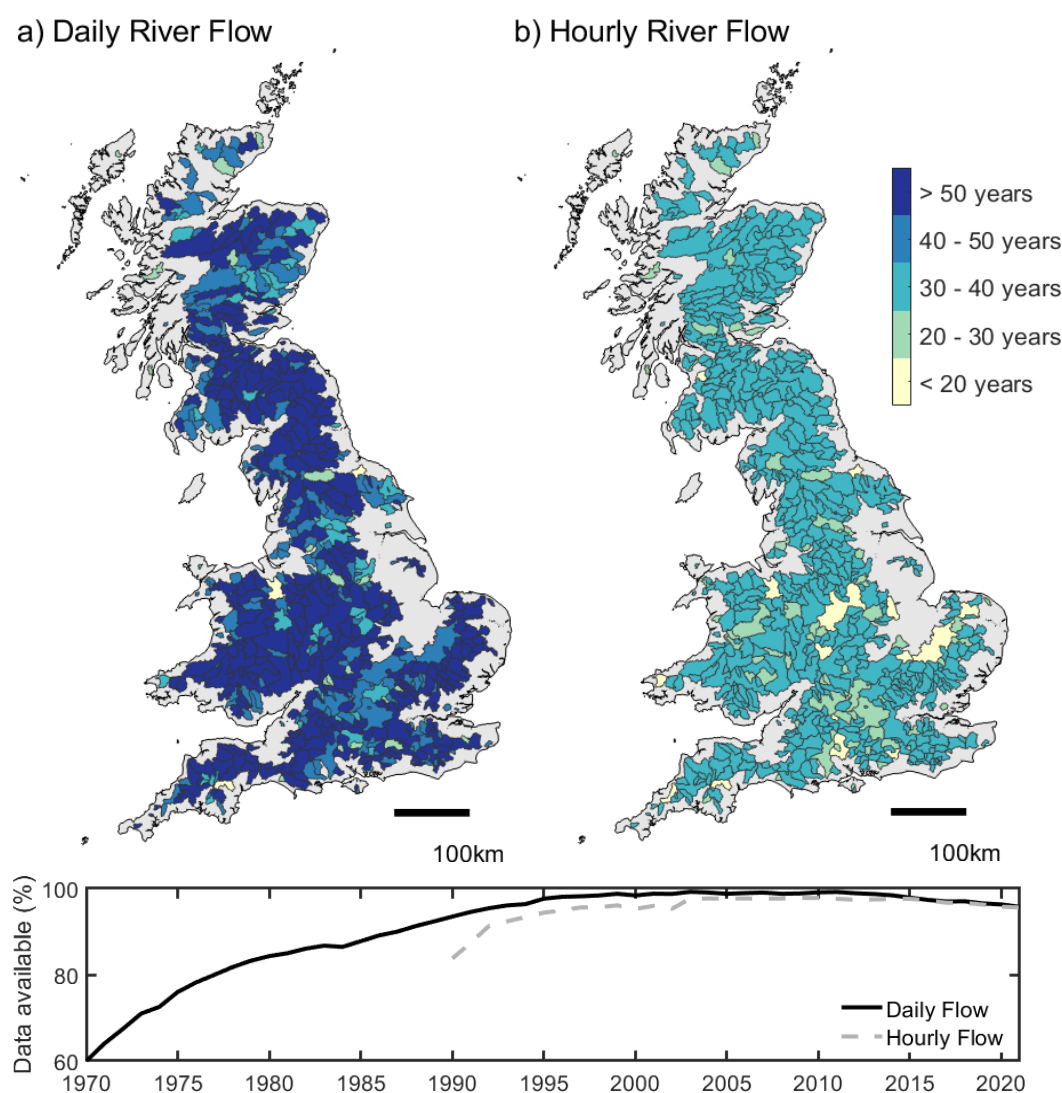


Figure 2. Flow data availability a) length of daily flow timeseries available for each catchment, b) length of hourly flow timeseries available for each catchment, c) percentage of daily and hourly data available for each year from 1970-2022 and 1990-2022. Contains OS data © Crown Copyright and database right 2025.

155 3.1.2 Daily hydrological timeseries

Daily streamflow data for the 671 gauges were taken from the UK NRFA on the 7th January 2025 (<https://nrfaapps.ceh.ac.uk/nrfa/nrfa-api.html>, last access 22nd January 2025). Streamflow data on the NRFA are provided by



measuring authorities who operate the river flow monitoring network, including the Environment Agency (EA) in England, Natural Resources Wales (NRW) in Wales and Scottish Environmental Protection Agency (SEPA) in Scotland. The streamflow data undergo additional quality control before being uploaded on the NRFA site. Streamflow data in CAMELS-GB v2 are provided as volumetric discharge ($\text{m}^3 \text{s}^{-1}$) and specific discharge (mm day^{-1}).

Figure 2 shows the daily flow data availability for all gauges contained in the CAMELS-GB v2 dataset (Figure 2a) and how this availability changes over time (Figure 2c). Nearly all (666) of the gauges have at least 20 years of daily flow data, and 86 % (577) of the gauges have at least 40 years of daily flow data (Figure 2a). Overall, there is good spatial coverage of long flow time series across Great Britain, with slightly shorter time series concentrated in the north, Midlands and south-east GB. Data availability increases over the time period with 60% of the daily flow data available in 1970, peaking to 99% in the early 2000's and slightly dropping to 96% by 2022 (Figure 2c).

3.2 Hourly hydro-meteorological timeseries

Hourly hydro-meteorological time series of rainfall and river flow are provided for the 671 catchments from 1st October 1990 09:00 to 1st October 2022 08:00 (Table 3). This provides a long-term, high-temporal resolution dataset for model forcing and evaluation, catchment characterisation and analysis of extremes (particularly short-term flood events). Hourly PET is not included in the hourly hydro-meteorological timeseries due to a lack of hourly PET datasets being available and observed hourly climate variables to calculate hourly PET.

3.2.1 Hourly meteorological timeseries

Hourly rainfall timeseries are derived from two national products so users have the choice from multiple products. The Gridded Estimates of hourly Areal Rainfall for Great Britain (CEH-GEAR1hr; Lewis et al., 2018, 2022) consists of 1km^2 gridded estimates of hourly rainfall from 1990-2016. The hourly rainfall estimates are derived from the temporal disaggregation of the CEH-GEAR daily data (described in Section 3.1.1) using hourly gauge data from the Met Office, EA, NRW and SEPA. The hourly gauge data are quality controlled to identify and reject erroneous hourly values in the gauge rainfall input dataset by comparing the gauge data with the CEH-GEAR daily dataset and by implementing a series of quality control tests (Lewis et al., 2018). The nearest neighbour interpolation methodology was used to generate the gridded hourly estimates which were subsequently used to disaggregate the daily data.

Hourly rainfall time series are also derived from the Gauge-Radar Precipitation Dataset (1 hour and 1 km) for Great Britain, GRaD-GB(1H1K), which takes advantage of the accuracy of gauge rainfall and the spatial information of radar rainfall field (Qiu et al., 2025a). The dataset consists of 1km^2 gridded estimates of hourly rainfall for Great Britain from 1 January 2006 to 31 December 2023 and is produced by blending 5-min NIMROD composite radar rainfall (Met Office, 2024) with sub-hourly rainfall observations of ~1800 rain gauge network from the UK Met Office, EA, NRW and SEPA. To produce the hourly rainfall dataset, the radar rainfall and sub-hour rainfall observations are first aggregated to hourly data. Then a quality control



framework is applied to improve the underestimation (radar beam blockage) and overestimation (radar malfunction, ground clutter, and random noise) issues in the radar rainfall data (Qiu et al., 2025b). The quality control procedure that was employed in CEH-GEAR1hr (Lewis et al., 2018) is applied to the gauge rainfall data. A Gauss Blending method was then used to merge the radar rainfall with gauge rainfall. Maintenance work on the rainfall radars means that 3.5% of the hourly timeseries are missing for the CAMELS-GB catchments due to missing radar data. Analysis of GRaD-GB(1H1K) shows that the dataset can capture extreme rainfall events missed by rain-gauges (i.e. severe flash flooding in Coverack, Cornwall, 18 July 2017) (Qiu et al., 2025a).

A comparison of the hourly rainfall timeseries from CEH-GEAR1hr and GRaD-GB(1H1K) (Figure 3) shows that on average, GRaD-GB(1H1K) hourly rainfall estimates are 10% higher than CEH-GEAR1hr (range of -25 - 65%) when calculating the average hourly rainfall using the full timeseries. There is more variability between the two products in the north of Great Britain (Figure 3a). The higher average rainfall for the GRaD-GB(1H1K) dataset is partially explained by a higher proportion of wet hours (an hour with >0.1 mm of rainfall) in GRaD-GB(1H1K) (Figure 3b), however, when the average hourly rainfall is calculated using only hours with >0.1 mm of rainfall, the relationship reverses and CEH-GEAR1hr has higher average hourly rainfall despite a lower proportion of wet hours (Figure S3). The CEH-GEAR1hr data are based on gauge data corrected to the daily total and it specifically seeks to preserve intense sub-daily rainfall characteristics in the interpolation method it uses. Therefore, it has fewer wet hours and more intense hourly rainfall than GRaD-GB(1H1K). There is also a relationship with elevation where catchments with lower median elevation have higher average rainfall in the GRaD-GB(1H1K) dataset compared to catchments with higher median elevation (Figure 3c). An example of the differences between the hourly rainfall datasets for individual catchments is shown in Figure S4 and S5.

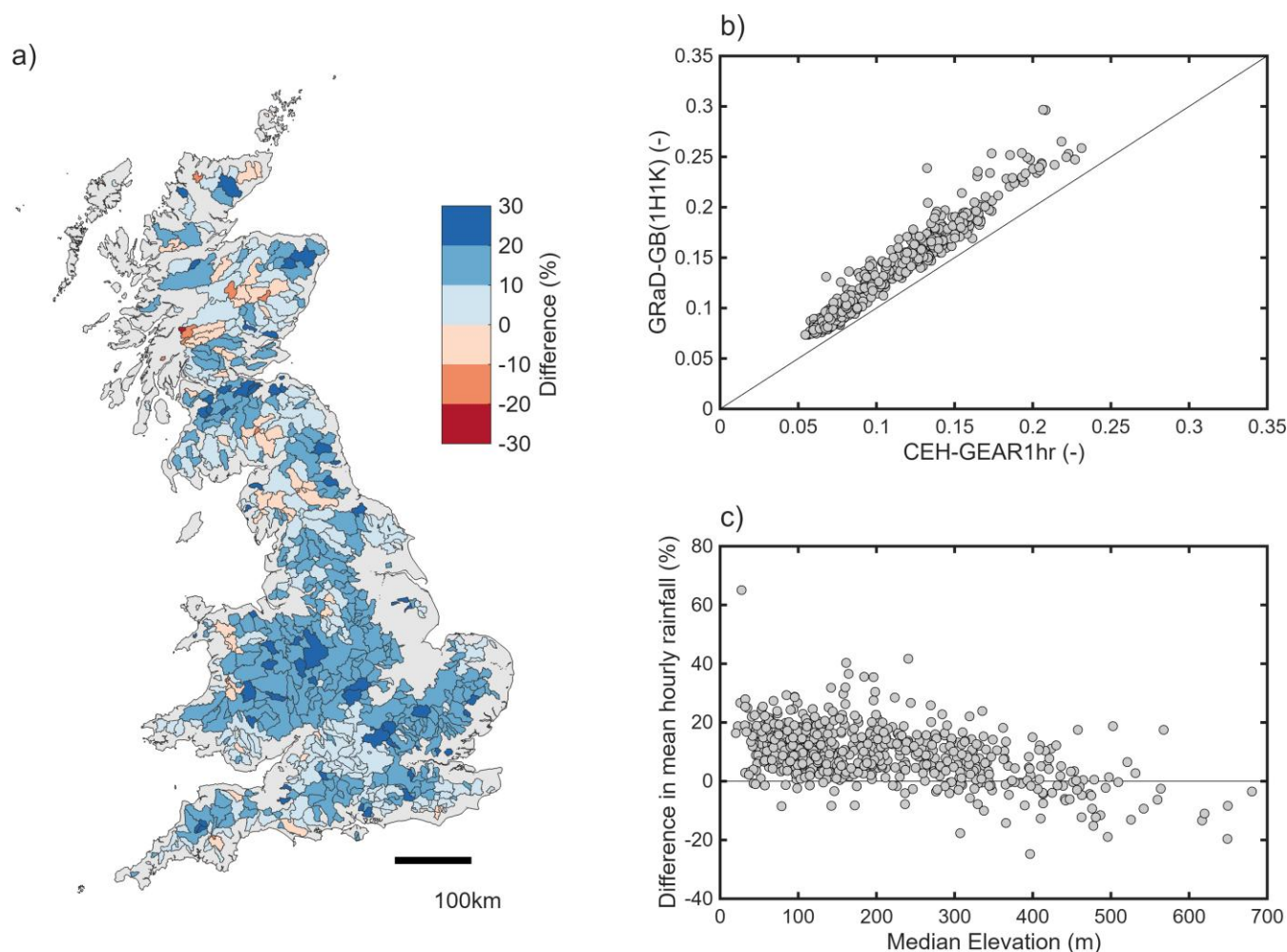


Figure 3. National comparison of average hourly rainfall (mm hour^{-1}) from 1st January 2006 to 31st December 2016 between CEH-GEAR1hr and the GraD-GB(1H1K) datasets for the 671 CAMELS-GB catchments, a) Difference in average hourly rainfall (average hourly rainfall calculated using all timesteps) (%), b) Fraction of wet hours (wet hours are defined as any hour that recorded rainfall $> 0.1\text{mm}$), c) Relationship between median elevation and difference in average hourly rainfall (%). The blue colours indicate that the GraD-GB(1H1K) hourly rainfall averages are higher than the CEH-GEAR1hr hourly rainfall averages, while the red colours indicate that the GraD-GB(1H1K) hourly rainfall averages are lower than the CEH-GEAR1hr hourly rainfall averages, as a percentage of the CEH-GEAR1hr dataset. Contains OS data © Crown Copyright and database right 2025

3.2.2 Hourly hydrological timeseries

Hourly river flows and levels are provided for 664 and 570 gauges respectively in CAMELS-GB v2 from 1st October 1990 – 30th September 2022. These hourly river flow and level data combined with the hourly rainfall data provide a wealth of



220 additional information beyond the daily data, particularly for flood analyses, convective storm responses, and other short-duration extremes (Figures S4 and S5).

Sub-daily river flows and levels are collected by the measuring authorities. The level data were obtained from SEPA via the timeseries data service (<https://timeseriesdoc.sepa.org.uk/>; last access 23rd September 2025), from EA primarily through the Hydrology Data Explorer (<https://environment.data.gov.uk/hydrology>; last access 23rd September 2025) and, where
 225 unavailable, with staff assistance, and from NRW entirely with staff assistance. The hourly flow data were obtained from the same sources but derived from the UK-Flow15 dataset (Fileni et al, 2025). UK-Flow15 is a quality-controlled 15-minute flow dataset for the UK, using records from over 1,300 gauging stations including the EA, SEPA and NRW, in addition to the Department for Infrastructure in Northern Ireland and the UK Centre for Ecology & Hydrology. The flow data have been quality controlled using both visual/manual inspection and automated quality control, including novel quality assessment
 230 techniques to assess the plausibility of extreme flow events (Fileni et al, 2025).

Here, the 15-minute flow and level data have been aggregated to hourly using a next-hour resample (e.g. 10:00 flow value is the mean of flow recorded at 9:15, 9:30, 9:45 and 10:00). Most gauges (650) have at least 20 years of hourly flow data and 86% (579) of the gauges have at least 30 years of hourly flow data (Figure 2b). There is good spatial coverage of long hourly flow time series across Great Britain, with shorter time series concentrated in the Midlands and south-east of Great Britain.
 235 Similar to the daily data, there is greater missing flow data in the earlier part of the record (1990-1995, Figure 2c). There is also good availability of level data where 80% (542) of gauges have at least 20 years of hourly level data and 74% (499) of gauges have at least 30 years of hourly level data.

The flow and level data are also provided with quality control flags. The quality flag for the corresponding hour was selected according to an order of priority (i.e. which flag was deemed to be most important; see Text S1 and Figure S6). No flow or
 240 level data have been removed or modified by the quality control process so users can decide which data they want to include as part of their analyses. Users are strongly encouraged to use the flag-based system to identify, remove, or interpolate potentially problematic data as per their study requirements to ensure that only good-quality data are utilised (see Fileni et al, 2025 for a more detailed assessment of the quality control process). The flags are grouped into three categories; (1) comparison with other data products (such as the daily NRFA data), (2) traditional QC checks (such as negative values, truncated low/high
 245 flows, spikes), and (3) high-flow QC checks (with comparison to antecedent rainfall and assessment of unrealistically high values) (see Tables S1-3 for a full description of the quality control codes). The levels data underwent less extensive quality control than the flow dataset, and do not include quality control flags for some anomaly checks, comparisons with other UK hydrological products and hydrological similarity flags (see Text S1).

The most common flag for hourly river flow (Figure S8) are where there is a mismatch of >5% between the 15-min values
 250 recorded in UK-Flow15 (aggregated to daily) and the National River Flow Archive daily values – this flag is recorded in the timeseries of 539 stations and can appear for over 90% of the timeseries for some gauging stations. The hourly flow data will



not always be consistent with the daily NRFA flow data because of rating curve changes, version control inconsistencies, and station-specific issues.

The other flags typically affect a relatively small proportion of the timeseries (this is expected as many flags focus on extremes) but will be important for users to identify, remove, or interpolate potentially problematic data as per their study requirements.

4 Groundwater levels

Groundwater level time series for 55 boreholes across Great Britain were obtained from the British Geological Survey (BGS) (Figure 4). These boreholes were selected to fall within CAMELS-GB catchments and represent the main aquifers in Great Britain. Groundwater level data are provided by the measuring authorities (EA, NRW and SEPA) to the National Groundwater Level Archive (NGLA) maintained by the British Geological Survey. Data are measured in meters above Ordnance Datum Newlyn (mAOD), which indicates the groundwater level height at a particular site relative to mean sea level using the national height datum in Britain.

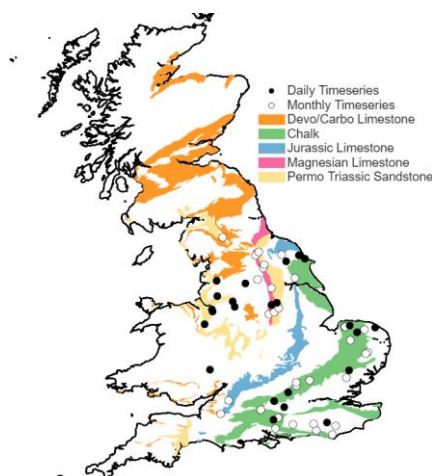


Figure 4. Location of 55 groundwater level timeseries in CAMELS-GB-v2. Underlying map shows main aquifers across Great Britain. Devo/Carbo is abbreviated from Devonian/Carboniferous. Contains British Geological Survey materials © UKRI [2025] and OS data © Crown Copyright and database right 2025.

The groundwater level data were provided at irregular time intervals. To provide a standardised dataset for CAMELS-GB-v2, the data were (1) aggregated to monthly by taking an average of all measurements in each calendar month to provide monthly groundwater level timeseries for all boreholes, and (2) also provided at daily timescale where consistent daily or subdaily groundwater level observations were provided. Consequently, monthly groundwater level time series are provided for all 55 boreholes and daily groundwater time series are also provided for 23 of these boreholes. The monthly groundwater timeseries are available for 7 – 72 years with the earliest records beginning in the 1950s. The earliest daily groundwater timeseries start



from 1993 and are occasionally averaged from subdaily data. For 23 of the boreholes, outliers in the monthly groundwater
 level timeseries were flagged as readings 1) diverted from the expected range, or 2) were close to the Datum (see Table S4).

Groundwater well attributes are also provided in CAMELS-GB v2, describing reference and hydrogeological information
 relating to the wells and boreholes where groundwater level timeseries are provided. For each groundwater well, the name,
 location (easting and northing), datum, depth and aquifer are provided. The start date, end date and percentage complete of the
 daily and/or monthly groundwater level timeseries provided in CAMELS-GB v2 are also provided.

5 Catchment attributes

Catchment attributes characterising location, topography, climate, hydrology, land cover, soils, hydrogeology, hydrometry and
 human influences are provided in CAMELS-GB v2. Most catchment attributes (location, topography, climate, hydrology, soils
 and hydrogeology) are the same as CAMELS-GB v1 and are re-calculated using the new catchment boundaries or re-extracted
 from the same source (to account for any changes) (Table 1). Key changes are made for (1) land cover, where changing land
 cover over multiple years are now provided, (2) hydrometry, where new peak flow information is provided and (3) human
 influences, where new abstraction, discharge and reservoir attributes are provided (Table 1). This section describes the
 CAMELS-GB v2 catchment attributes including the source datasets, processing and limitations.

5.1 Location, area and topographic data

Catchment attributes describing the location and topography are kept consistent with CAMELS-GB v1 but are re-extracted for
 each catchment from the NRFA to ensure the latest version of these data. Catchment elevation (min, 10th, 50th, 90th, max)
 within the catchment mask is derived from CEH's 50m Integrated Hydrological Digital Terrain Model. Mean elevation and
 mean drainage path slope (index of catchment steepness) are also provided based on methods developed for the Flood
 Estimation Handbook (Bayliss, 1999), except for two catchments (18011 and 26006) where catchment boundaries could not
 be automatically derived. For more information see Section 6.1 of Coxon et al., (2020).

5.2 Climatic indices

The same suite of climatic indices is calculated as CAMELS-GB v1 (and other CAMELS datasets). These climatic indices
 characterise long-term (i.e. mean precipitation and PET, aridity index), seasonal (i.e. rainfall seasonality and fraction of snow),
 and short-term (i.e. frequency, duration and timing of high and low precipitation events) climate dynamics. The climatic indices
 in CAMELS-GB v2 are derived using the HadUK-Grid catchment daily rainfall, potential evapotranspiration (without
 correction for interception), and temperature time series described in Section 3.1.1 of this paper. These data were chosen (rather
 than the CEH-GEAR and CHESS-PE data) as the HadUK-Grid data cover the full timeseries available.



5.3 Hydrologic signatures

The same suite of hydrologic signatures is calculated as CAMELS-GB v1 (and other CAMELS datasets). The hydrologic signatures characterise long-term (i.e. mean flow, runoff ratio, streamflow elasticity, baseflow index), seasonal (i.e. the half low date), and short-term (i.e. high and low flow percentiles, frequency and duration of high and low streamflow events) streamflow dynamics. The hydrologic signatures in CAMELS-GB v2 are derived using the HadUK-Grid catchment daily rainfall and streamflow time series from 1 October 1970 to 30 September 2022 (Section 3.1.1 and 3.1.2). Users should consider the availability of streamflow data (i.e. length and percentage missing) when comparing hydrologic signatures across catchments (McMillan et al, 2023).

5.4 Land cover attributes

Land cover for multiple years is provided in CAMELS-GB v2. Land cover attributes for each catchment were derived from the UK Land Cover Map 1990, 2015, 2017, 2018, 2019, 2020, 2021 and 2022 produced by UK CEH (Marston et al., 2022, 2024; Morton et al., 2020a, b, c, 2021; Rowland et al., 2017, 2020). While there are also land cover maps produced by UK CEH for 2000 and 2007, these do not use a consistent methodology for derivation of their land cover classes, preventing straightforward analysis of changes in land cover over time.

The land cover maps are derived by classifying satellite imagery into 21 classes based on the Joint Nature Conservation Committee (JNCC) broad habitats. Like CAMELS-GB v1, these 21 classes are mapped to eight land cover classes that describe deciduous woodland, evergreen woodland, grass and pasture, shrubs, crops, suburban and urban, inland water, bare soil, and rocks. For CAMELS-GB v2, we use the 25 m raster data from the range of LCM products consisting of the most likely land cover type for each grid cell. For each catchment, the percentage of the catchment covered by each of the eight land cover types was calculated and is provided in CAMELS-GB v2 for 1990, 2015, 2017, 2018, 2019, 2020, 2021 and 2022 (Table 5).

Users should be aware that while advances in methods mean land cover is more consistent between years, there are still issues around accuracy, stability between years and the strength of the change signal. This means that while some of the land cover change between years is real, there is also noise in the variability between years. This could be due to (1) the timing and quality of satellite imagery, particularly in high elevation catchments where there is often limited satellite imagery due to snowy/cloudy conditions, (2) differences in methods applied between years and (3) confusion in land cover classes (Rowland et al., 2024). As an example, we show changes in urban land cover for catchments in CAMELS-GB v2 in Figure S9. While a trend of increasing land cover over time is apparent for many catchments, there is variability between years and most catchments experience a decrease in urban cover from 2021-2022 that is unlikely to be reflected in the real world.



325 5.5 Soil attributes

Soil attributes are the same as CAMELS-GB v1 but derived using the updated catchment boundaries described in Section 2. A brief summary of the underlying data is provided here, with a full summary provided in Section 6.5 of Coxon et al., (2020).

Soil attributes of depth available to roots, percentage sand, silt and clay content, organic carbon content, bulk density, and total available water content for each catchment were calculated from the European Soil Database Derived Data product (Hiederer, 330 2013a, b). Saturated hydraulic conductivity and porosity (saturated volumetric water content) were also estimated from these variables using two pedo-transfer functions (based on Cosby et al, 1984 and Wosten et al, 1999, 2000, 2001). A weighted mean of the topsoil and subsoil data was calculated for all 1km grid cells and then used to calculate average soil properties for each catchment either by calculating the arithmetic mean or harmonic mean (for saturated hydraulic conductivity, Samaniego et al., 2010) of all 1km grid cells within the catchment boundary. To capture the spatial heterogeneity and data availability of 335 the soils data, the 5th, 50th, and 95th percentile and percentage of no-data values of all grid cell values falling within the catchment boundaries are also provided.

5.6 Hydrogeological attributes

Hydrogeological attributes are the same as CAMELS-GB v1 but derived using the updated catchment boundaries described in Section 2. A brief summary of the underlying data is provided here, with a full summary provided in Section 6.6 of Coxon et 340 al., (2020).

Hydrogeological attributes were derived from products produced by the British Geological Survey; the UK bedrock hydrogeological map (BGS, 2019) and a superficial deposit productivity map. These two datasets were merged to categorise the uppermost geological layer into nine classes that account for superficial deposits (where present) and bedrock (where superficial deposits are absent). The nine classes indicate how hydrogeology affects river flow behaviour by characterising the proportion of the catchment that is covered by deposits that have high, moderate, or low productivity, and whether the dominant 345 water flow is through fractures or between grains (Table 5).

5.7 Hydrometry and discharge uncertainty attributes

The hydrometry and discharge uncertainty attributes describe the gauging station type (i.e. the type of weir, structure, or measurement device used to measure flows), period of flow data available (i.e. start date, end date and percentage complete), 350 gauging station discharge uncertainty, peak flow information (i.e. the maximum gauged flow and percentage of extrapolation and channel characteristics (such as bankfull) (see Table 5). Many of these attributes are the same as CAMELS-GB v1. The gauging station type and channel characteristics were re-extracted from the NRFA with changes for a small number of stations where the gauging station type has changed since CAMELS-GB v1. The period of flow data were updated for the daily timeseries and new catchment attributes added to describe the period of hourly flow data. The gauging station discharge



355 uncertainties were calculated using the same method from Coxon et al., (2015) but updated so that discharge uncertainties were calculated from flow percentiles from the longer streamflow timeseries. A full description of the discharge uncertainty attributes is provided in Section 6.7 of Coxon et al., (2020).

New hydrometry attributes were added describing peak flow information; including the (1) maximum gauging flow (the highest manual measurement of flow taken at a gauging station) and the date this maximum gauging flow was taken, (2) the maximum daily/hourly flow recorded in the catchment timeseries in CAMELS-GB v2, and (3) the percentage of time (excluding NaNs) that the daily/hourly flow timeseries in CAMELS-GB v2 is higher than the maximum gauging flow. Figure 5 shows that for most gauges (70% for daily and 69% for hourly), the flow is extrapolated above the maximum flow gauging for a small proportion (<1%) of the time series, with relatively few gauges exceeding 1% of the timeseries (4% of gauges for daily flow and 5% for hourly). However, one gauge (NRFA gauge ID 40010) has more than 30% of the flow timeseries extrapolated above the maximum flow gauging and for some gauges the highest hourly/daily flow can be more than 10x bigger than the maximum flow gauging (Figure 5c). For 16% (daily) and 36% (hourly) of the gauges where maximum flow gauging is available, the maximum daily/hourly flow is 2x bigger than the maximum flow gauging. It is worth noting that (1) peak flow information is not available for 26% of CAMELS-GB gauges as they have no maximum flow gauging recorded on the NRFA website, (2) the discharge uncertainty estimates provided in CAMELS-GB v2 are based on an older set of gaugings which means that there might be some inconsistencies where we are able to calculate uncertainty bounds with the peak flow discharge uncertainties and (3) sometimes the maximum daily/hourly flow is lower than the maximum gauging flow because a higher flow has occurred at the gauging station outside of the time period provided in CAMELS-GB v2.

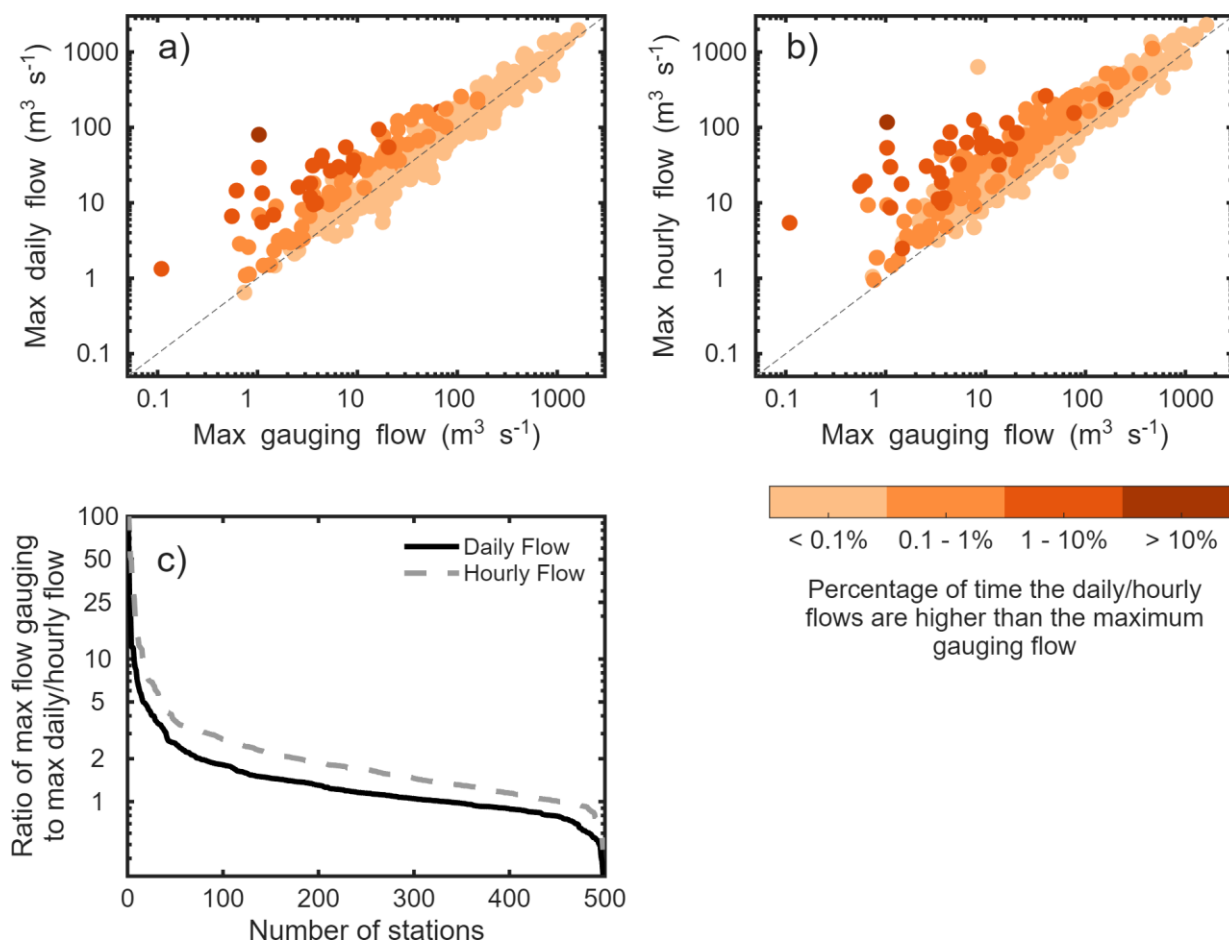


Figure 5. Comparison of the maximum gauging flow with a) maximum daily flow and b) maximum hourly flow recorded in the catchment timeseries in CAMELS-GB v2, where dots are coloured by the percentage of time (excluding NaNs) that the daily/hourly flow timeseries in CAMELS-GB v2 is higher than the maximum gauging flow. c) ratio of maximum flow gauging to maximum daily/hourly flow in flow timeseries in CAMELS-GB v2.

5.8 Human influence attributes

CAMELS-GB contains many catchments impacted by human activities, so we aim to provide attributes that help users quantify and characterise human influences in each of the catchments. New, open-source datasets are used to quantify average abstraction and discharge in each catchment, and we provide new reservoir attributes characterising the size and location of the reservoirs relative to the gauge.

5.8.1 Benchmark catchments

The UK Benchmark Network contains 146 catchments where human impacts on flow regimes are assumed to be minimal (Harrigan et al., 2018). All CAMELS-GB catchments are identified as either being part of this network or not to provide users



with an indication of ‘near-natural’ catchments and suitable for studies where human impacts need to be minimal. Users should be aware that to ensure coverage in the south and east of GB (where there are lots of human influences on river flows), some human impacts were accepted.

390 5.8.2 Abstraction and discharges

Average daily abstraction and discharge rates are provided again in CAMELS-GB v2 but based on a new dataset of abstractions and discharges (Rameshwaran et al., 2025). This new dataset is based the same underlying data as used in CAMELS-GB v1 but underwent additional quality control and is now available open source.

The abstraction data consist of the total water quantity (in most cases measured using a water meter) that has been abstracted
 395 for each licence and each month from 1999 to 2014 in England on a 1km grid. These monthly abstraction data were averaged to provide a mean monthly abstraction from 1999 to 2014 for each abstraction licence and then aggregated for each catchment to provide a mean daily abstraction rate for all English catchments in CAMELS-GB v2 for groundwater and surface water sources. The use of the abstracted water (agriculture, amenities, environmental, industrial, energy, or water supply) is also provided and how much of the abstracted water is consumed/lost (high- 100%, medium – 60%, low – 3% and very low –
 400 0.3%). For example, cress pond throughflow is described as very low loss, whilst farming and water supply is classed as medium loss, and trickle irrigation is classed as high. These loss factors are only used for billing purposes and therefore indicative of the true water consumption.

The discharges data consist of recent actual discharges for England from the WRGIS (Water Resources Geographic Information System). These data represent discharges from sewage treatment works and other ‘significant’ discharges
 405 (typically those $>20 \text{ m}^3 \text{ day}^{-1}$) using an estimate of recent actual summer discharge. For each catchment, we calculate a sum of all the discharges that fall within the catchment boundary and then convert into millimetres per day using catchment area to provide a mean daily discharges rate.

There are several limitations associated with these data. Firstly, these catchment attributes are only available for England and there are many catchments where either (1) no data are available (identified by “NaN”), (2) abstractions or discharges are
 410 recorded in zero when in reality they are not, or (3) only a proportion of the abstractions/discharges are accounted for, as the catchments lie on the border of England–Wales or England–Scotland. Secondly, the topographical catchment mask was used to define which abstraction returns were included in each catchment which will not be representative for groundwater abstractions that lie within the topographical catchment but do not have a direct impact on the catchment streamflow or those that lie outside the catchment but have an impact on that catchment’s streamflow. Thirdly, this is not the full picture of human
 415 influences within each catchment. Not all licence types/holders are required to submit records to the Environment Agency; the abstraction data used here does not hold returns for abstractions less than $20 \text{ m}^3 \text{ day}^{-1}$, and from 2008, abstraction licence-holders less than $100 \text{ m}^3 \text{ day}^{-1}$ were no longer required to submit records of abstraction. Furthermore, there is large inter-annual



and intra-annual variation in the abstraction and discharge data, and its impacts will be different across the flow regime. Finally, while abstractions represent water removed from surface water or groundwater sources, some of this water will be returned to catchment storages. This is partially represented by the loss factor and discharges information but the relationship between discharge consent data and water returned from abstractions will often be more complex than these simple attributes.

5.8.3 Reservoirs

For CAMELS-GB v2, several reservoir attributes are derived for each catchment by determining the reservoirs that lie within the catchment mask from the reservoir locations and then calculating (1) the number of reservoirs in each catchment; (2) their combined capacity; (3) the fraction of that capacity that is used for hydroelectricity, navigation, drainage, water supply, flood storage, and environmental purposes; (4) the year when the first and last reservoirs in the catchment were built, and (5) the contributing area and normalised upstream capacity.

The first four sets of reservoir attributes are the same as CAMELS-GB v1 and calculated from the open-source UK reservoir inventory (Durant and Counsell, 2018) supplemented with information from SEPA's publicly available controlled reservoirs register. For CAMELS-GB v2, we excluded 43 reservoirs from the inventory as they could not be placed on the river network largely because their outflow or inflow location was unclear (see Figure S1 in Salwey et al., 2023) and therefore the new reservoir attributes could not be calculated. This leads to only minor differences with CAMELS-GB v1 (Figure S10).

Two new reservoir attributes are included in CAMELS-GB v2; contributing area and normalised upstream capacity. These attributes were chosen due to previous studies finding clear links between the size and location of upstream reservoirs and the associated flow alteration for UK catchments (Salwey et al., 2023).

Contributing area describes the percentage of the overall catchment surface area that is drained through reservoirs:

$$\text{Contributing area (\%)} = \frac{\text{catchment area drained by reservoirs (km}^2\text{)}}{\text{total catchment area (km}^2\text{)}} \times 100$$

In CAMELS-GB v2, the mean contributing area is 18%, with a maximum of 100%. The contributing area is complemented by the normalised upstream capacity, which compares the capacity of a reservoir to the average volume of precipitation received by the catchment in a year:

$$\begin{aligned} &\text{Normalised upstream capacity} \\ &= \frac{\text{total upstream reservoir capacity (mm}^3\text{)}}{\text{total catchment area (mm}^2\text{)} * \text{average annual catchment precipitation (mm)}} \end{aligned}$$

In CAMELS-GB v2, the average normalised upstream capacity is 0.08 (i.e. the reservoir is large enough to store 8% of average annual rainfall) with a maximum of 2.5 (i.e. the reservoir is large enough to store 250% of average annual rainfall). Ten catchments have a normalised upstream capacity greater than 0.25.



6 Data availability

The CAMELS-GB v2 dataset available under an Open Government License via the UK Centre for Ecology & Hydrology Environmental Information Data Centre (Coxon et al., 2025; <https://doi.org/10.5285/9a46d428-958f-4ac1-86eb-94eee70c0955>). The data contain catchment boundaries, hydro-meteorological and groundwater time series (at hourly, daily
450 and monthly time-scales), catchment attributes and groundwater well attributes as described above. The data format is described in the supporting documentation available on the UK Centre for Ecology & Hydrology Environmental Information Data Centre.

7 Code availability

The exactextract Python package (Baston, 2025) is used to extract catchment average data from gridded datasets based on the
455 catchment boundary polygons described in Section 2. The code from <https://github.com/naddor/camels> (last access: 23rd September 2025) was used to generate the climatic indices and hydrological signatures.

8 Conclusions

This paper presents the second version of CAMELS-GB. CAMELS-GB v2 collates millions of observations from across Great Britain at hourly to monthly timescales, including quality-controlled daily river flows, catchment boundaries, and catchment
460 characteristics from the UK National River Flow Archive. The new features include (1) extended daily hydro-meteorological timeseries up to 2022 including meteorological timeseries from new observed climate datasets, (2) new hourly precipitation, river flows and level timeseries, (3) new groundwater level timeseries and attributes for 55 groundwater wells, and (4) new catchment attributes characterising changing land cover, peak flows and human influences.

CAMELS-GB v2 provides exciting new opportunities for environmental and modelling analyses across Great Britain. This
465 includes enabling the development of common frameworks for model evaluation and benchmarking at regional to national scales and the analysis of hydrologic variability across the UK. The new sub-daily hydro-meteorological timeseries provide a wealth of additional information beyond the daily data, particularly for flood analyses, convective storm responses, and other short-duration extremes. The new catchment attributes enable users to explore how different catchment characteristics control river flow behaviour, particularly in human-influenced catchments. Future updates to the dataset will concentrate on greater
470 spatial and temporal coverage of the groundwater level data and river network characteristics (e.g. Strahler Index).



9 Author Contribution

GC led and produced CAMELS-GB v2 with the following contributions: (1) YZ derived all the catchment timeseries data from gridded datasets, (2) FF produced the hourly flow and level timeseries with contributions from HF, EL, MF, HC and HH, (3) XQ produced the GRaD-GB(1H1K) with contributions from HF, AG and EL, (4) MF and RB provided the daily streamflow data, catchment boundaries and all catchment attributes sourced from the National River Flow Archive, (5) TG provided the groundwater level timeseries, DEW processed these timeseries and produced the groundwater attributes, (6) GN derived the soils and abstraction attributes, (7) SS derived the climatic attributes, hydrologic signatures, hydrogeology attributes and the reservoir attributes, (8) HC facilitated the upload of the dataset to the EIDC. All co-authors contributed to the design of the dataset. The manuscript was prepared by GC with contributions from all co-authors.

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Tables

Table 1 Summary of changes to CAMELS-GB dataset for version 2

Data		Data provided in CAMELS-GB v1	Change for CAMELS-GB v2	Section
Catchments		671 catchments across Great Britain	No change to number of catchments or catchment selection. Catchment boundaries updated.	2
Timeseries	Daily hydro-meteorological timeseries	Timeseries available from 1 st October 1970 - 30 th September 2015 for streamflow, rainfall, potential evapotranspiration, temperature, wind speed, humidity, short-wave and long-wave radiation.	New timeseries data for rainfall, PET and temperature from the HadUK dataset to provide multiple estimates of climatic variables with an extended timeseries up to 30 th September 2022. CEH-GEAR rainfall and CHESSTimeseries are extended to 30 th September 2019. No longer providing wind speed, humidity, short-wave radiation and long-wave radiation as these were rarely used.	3.1
	Hourly hydro-meteorological timeseries	None provided	Hourly streamflow, river level and rainfall (from two products) from 1 st October 1990 – 30 th September 2022.	3.2
	Groundwater level timeseries	None provided	Daily groundwater level timeseries for 23 wells from 1993-2025 and monthly groundwater level timeseries for 55 wells from 1952-2025.	4
Catchment Attributes	Location and Topography	Hydrometry attributes included gauge ID, location, catchment area and elevation percentiles	The same attributes are provided but updated to the latest information from the UK National River Flow Archive.	5.1
	Climatic	Climatic indices including mean rainfall and PET,	The same climatic indices are provided but calculated using the	5.2



		aridity index, seasonality, snow fraction and frequency, duration and timing of climatic extremes were provided for each catchment. Derived using daily meteorological timeseries.	extended Had-UK daily rainfall, temperature and PET timeseries.	
	Hydrologic	Hydrologic signatures including mean streamflow, runoff ratio, slope of the flow duration curve, baseflow index, frequency, duration and timing of low/high flow events were provided for each catchment. Derived using daily hydro-meteorological timeseries.	The same hydrologic signatures are provided but calculated using the extended Had-UK daily rainfall and daily streamflow timeseries.	5.3
	Land Cover	Land cover percentages for eight land cover classes provided for each catchment for a single year (2015).	Land cover for multiple years is provided including 1990, 2015, 2017, 2018, 2019, 2020, 2021 and 2022. Same land cover classes are provided.	5.4
	Soils	Soil attributes characterising the soil texture, porosity, saturated conductivity and depth.	The same soil attributes are re-calculated using the same underlying data but with the new catchment boundaries (very little change).	5.5
	Hydrogeology	Hydrogeological attributes characterising the upper geological layer describing the proportion of the catchment covered by deposits of high, moderate, or low productivity and whether this is	The same hydro-geological attributes are re-calculated using the same underlying data but with the new catchment boundaries (very little change).	5.6



		predominantly via fracture or intergranular flow.		
	Hydrometry	Hydrometry and discharge uncertainty attributes describing the gauging station type, period of flow data available, gauging station discharge uncertainty and channel characteristics were provided for each catchment.	The same attributes are provided but updated to latest information from the UK National River Flow Archive. New hydrometry attributes are provided to characterise peak flow information.	5.7
	Human Influences	Human influence attributes describing abstractions, discharges and reservoir attributes were provided for each catchment.	Abstractions and discharges are based on a new open-access dataset and new attributes added describing the loss factor of abstractions. New attributes added describing the reservoir contributing area and normalised upstream capacity.	5.8
Groundwater well attributes	Groundwater Wells	None provided	Groundwater well attributes are provided, describing reference and hydrogeological information relating to the wells and boreholes where groundwater level timeseries are provided.	4

Table 2 Summary table of catchment daily hydro-meteorological timeseries available in CAMELS-GB v2

Timeseries Class	Timeseries Name	Description	Unit	Data Source
Meteorological Timeseries (available from	precipitation_cehgear	catchment averaged daily precipitation	mm day ⁻¹	CEH-GEAR (Keller et al., 2015; Tanguy, 2021)



1 st October 1970 – 30 th September 2022)	precipitation_haduk	catchment averaged daily precipitation	mm day ⁻¹	HadUK-Grid (Hollis et al., 2019)
	pet_chess	catchment averaged daily potential evapotranspiration for a well-watered grass (Penman-Monteith equation)	mm day ⁻¹	CHESS-PE (Robinson et al., 2017b, 2023b)
	peti_chess	catchment averaged daily potential evapotranspiration for a well-watered grass (Penman-Monteith equation with a correction added for interception on days where rainfall has occurred)	mm day ⁻¹	
	pet_hydrop	catchment averaged daily potential evapotranspiration for a well-watered grass (Penman-Monteith equation)	mm day ⁻¹	Hydro-PE (Brown et al., 2023; Robinson et al., 2023c)
	peti_hydrop	catchment averaged daily potential evapotranspiration for a well-watered grass (Penman-Monteith equation with a correction added for interception on days where rainfall has occurred)	mm day ⁻¹	
	temperature_chess	catchment averaged daily temperature	°C	CHESS-met (Robinson et al., 2023a)
	temperature_haduk	catchment averaged daily temperature	°C	HadUK-Grid (Hollis et al., 2019)
Hydrological Timeseries (available from 1 st October 1970 – 30 th September 2022)	discharge_spec	catchment specific discharge (converted to mm day ⁻¹ using catchment areas described in Section 2)	mm day ⁻¹	UK National River Flow Archive using the NRFA API*
	discharge_vol	catchment discharge	m ³ s ⁻¹	



* <https://nrfaapps.ceh.ac.uk/nrfa/nrfa-api.html>, data downloaded on the 7th January 2025, last access to website 23rd September 2025

Table 3 Summary table of catchment hourly hydro-meteorological timeseries available in CAMELS-GB v2

Timeseries Class	Timeseries Name	Description	Unit	Data Source
Meteorological Timeseries (available from 1 st October 1990 09:00 – 1 st October 2022 08:00)	precipitation_cehgear	catchment hourly averaged precipitation from 1 st October 1990 - 31 st December 2019	mm hour ⁻¹	CEH-GEAR1hr (Lewis et al., 2018, 2022)
	precipitation_gradgb	catchment hourly averaged precipitation from 1 st January 2006 - 31 st December 2023	mm hour ⁻¹	Gauge-Radar Precipitation Dataset (1 hour and 1 km) for Great Britain, GRaD-GB(1H1K) (Qiu et al., 2025b, a)
Hydrological Timeseries (available from 1 st October 1990 09:00 – 1 st October 2022 08:00)	discharge_spec	catchment specific discharge (converted to mm hour ⁻¹ using catchment areas described in Section 2)	mm hour ⁻¹	The flows and level data were obtained from SEPA via the timeseries data service (https://timeseriesdoc.sepa.org.uk/ ; last access 23rd September 2025), from EA primarily through the Hydrology Data Explorer (https://environment.data.gov.uk/hydrology ; last access 23rd September 2025) and, where unavailable, with staff assistance, and from NRW entirely with staff assistance. Flags were derived from UKFlow-15 (Fileni et al., 2025).
	discharge_vol	catchment discharge	m ³ s ⁻¹	
	discharge_flag	numeric flag that indicates the quality of the flow data (full description of flags can be found in Figure S5 and Table S1-S3)	-	
	level	height of the river (measured in metres above river bed)	m	
	level_flag	numeric flag that indicates the quality of the level data (full description of flags can be found in Figure S5 and Table S1-S3)	-	



Table 4. Summary table of daily and monthly groundwater level timeseries available in CAMELS-GB v2

Timeseries Class	Timeseries Name	Description	Unit	Data Source
Groundwater Level Timeseries (daily and monthly timeseries for variable time periods)	groundwater_level	groundwater level for a specific borehole at either daily or monthly timesteps.	mAOD	British Geological Survey (BGS), National Groundwater Level Archive [online]. Available at: https://www2.bgs.ac.uk/groundwater/datainfo/levels/ngla.html (Accessed: 01 Feb 2025).



Table 5. Summary table of attributes available in CAMELS-GB v2

Attribute Class	Attribute Name	Description	Unit	Data Source
Location and Topography	gauge_id	catchment identifier (corresponds to the gauging station ID provided by the NRFA)	-	UK National River Flow Archive using the NRFA API*
	gauge_name	gauge name (river name followed by gauging station name)	-	
	gauge_lat	gauge latitude	°	
	gauge_lon	gauge longitude	°	
	gauge_easting	gauge easting	m	
	gauge_northing	gauge northing	m	
	gauge_elev	gauge elevation	m.a.s.l	
	area	catchment area	km ²	CEH's Integrated Hydrological Digital Terrain Model (Morris and Flavin, 1990)
	dpsbar	catchment mean drainage path slope	m km ⁻¹	
	elev_mean	catchment mean elevation	m.a.s.l	
	elev_min	catchment minimum elevation	m.a.s.l	
	elev_10	catchment 10 th percentile elevation	m.a.s.l	
	elev_50	catchment median elevation	m.a.s.l	
	elev_90	catchment 90 th percentile elevation	m.a.s.l	
	elev_max	catchment maximum elevation	m.a.s.l	
Climatic Indices (computed for 1st Oct 1970 to 30th Sept 2022)	p_mean	mean daily precipitation	mm day ⁻¹	Catchment timeseries of precipitation, potential evapotranspiration and temperature described in Section 3.1.1 and Table 2
	pet_mean	mean daily PET (Penman-Monteith equation without interception correction)	mm day ⁻¹	
	aridity	aridity, calculated as the ratio of mean daily potential evapotranspiration to mean daily precipitation	-	
	p_seasonality	seasonality and timing of precipitation (estimated using sine curves to represent the annual temperature and precipitation cycles; positive (negative) values indicate that precipitation peaks in summer	-	



		(winter) and values close to zero indicate uniform precipitation throughout the year)		
	frac_snow	fraction of precipitation falling as snow (for days colder than 0°C)	-	
	high_prec_freq	frequency of high precipitation days (≥ 5 times mean daily precipitation)	days yr ⁻¹	
	high_prec_dur	average duration of high precipitation events (number of consecutive days ≥ 5 times mean daily precipitation)	days	
	high_prec_timg	season during which most high precipitation days (≥ 5 times mean daily precipitation) occur. If two seasons register the same number of events, a value of NaN is given.	season	
	low_prec_freq	frequency of dry days ($< 1\text{mm day}^{-1}$)	days yr ⁻¹	
	low_prec_dur	average duration of dry periods (number of consecutive days $< 1\text{mm day}^{-1}$)	days	
	low_prec_timg	season during which most dry days ($< 1\text{mm day}^{-1}$) occur. If two seasons register the same number of events, a value of NaN is given.	season	
Hydrologic Signatures (computed for 1st Oct 1970 to 30th Sept 2022)	q_mean	mean daily discharge	mm day ⁻¹	Catchment timeseries of streamflow and precipitation described in Sections 3.1.2 and 3.1.1 respectively, and Table 2
	runoff_ratio	runoff ratio, calculated as the ratio of mean daily discharge to mean daily precipitation	-	
	stream_elas	streamflow precipitation elasticity (sensitivity of streamflow to changes in precipitation at the annual timescale, using the mean daily discharge as reference)	-	



	slope_fdc	slope of the flow duration curve (between the log-transformed 33 rd and 66 th streamflow percentiles)	-	
	baseflow_index	baseflow index (ratio of mean daily baseflow to daily discharge, hydrograph separation performed using the Ladson et al., 2013 digital filter)	-	
	baseflow_index_ceh	baseflow index (ratio of mean daily baseflow to daily discharge, hydrograph separation performed using the Gustard et al., 1992 method described in Appendix A)	-	
	hfd_mean	mean half-flow date (date on which the cumulative discharge since 1 October reaches half of the annual discharge)	days since 1st October	
	Q5	5% flow quantile (low flow)	mm day ⁻¹	
	Q95	95% flow quantile (high flow)	mm day ⁻¹	
	high_q_freq	frequency of high-flow days (> 9 times the median daily flow)	days yr ⁻¹	
	high_q_dur	average duration of high flow events (number of consecutive days >9 times the median daily flow)	days	
	low_q_freq	frequency of low flow days (< 0.2 times the mean daily flow)	days yr ⁻¹	
	low_q_dur	average duration of low flow events (number of consecutive days < 0.2 times the mean daily flow)	days	
	zero_q_freq	frequency of days with Q = 0	%	
Land Cover Attributes	dwood_perc_Y YYY	percentage cover of deciduous woodland for that year (YYYY)	%	25 m raster data, Land Cover Map 1990, 2015, 2017,
	ewood_perc_Y YYY	percentage cover of evergreen woodland for that year (YYYY)	%	



	grass_perc_YY YY	percentage cover of grass and pasture for that year (YYYY)	%	2018, 2019, 2020, 2021, 2022 (Marston et al., 2022, 2024; Morton et al., 2020a, b, c, 2021; Rowland et al., 2017, 2020)
	shrub_perc_YY YY	percentage cover of medium scale vegetation (shrubs) for that year (YYYY)	%	
	crop_perc_YYY Y	percentage cover of crops for that year (YYYY)	%	
	urban_perc_YY YY	percentage cover of suburban and urban for that year (YYYY)	%	
	inwater_perc_Y YYY	percentage cover of inland water for that year (YYYY)	%	
	bares_perc_YY YY	percentage cover of bare soil and rocks for that year (YYYY)	%	
Soil Attributes Each soil attribute is accompanied by the percentage missing and the 5th, 50th and 95th percentile (apart from percentage sand, silt, clay and organic content) of that attribute across the catchment	sand_perc	percentage sand	%	European Soil Database Derived Data product (Hiederer, 2013a, b), and the modelled depth to bedrock global product (Pelletier et al., 2016)
	silt_perc	percentage silt	%	
	clay_perc	percentage clay	%	
	organic_perc	percentage organic content	%	
	bulkdens	bulk density	g cm ⁻³	
	tawc	total available water content	mm	
	porosity_cosby	volumetric porosity (saturated water content estimated using a pedotransfer function based on sand and clay fractions)	-	
	porosity_hyres	volumetric porosity (saturated water content estimated using a pedotransfer function based on silt, clay and organic fractions, bulk density and topsoil)	-	
	conductivity_co sby	saturated hydraulic conductivity (estimated using a pedotransfer function based on sand and clay fractions)	cm h ⁻¹	
	conductivity_hy pres	saturated hydraulic conductivity (estimated using a pedotransfer function based on silt, clay and organic fractions, bulk density and topsoil)	cm h ⁻¹	
	root_depth	depth available for roots	m	



	soil_depth_pelle tier	depth to bedrock (maximum 50m)	m	
Hydrogeology Attributes	inter_high_perc	significant intergranular flow – high productivity	%	British Geological Survey hydrogeology map (BGS hydrogeology 625k, 2019) and superficial deposits map
	inter_mod_perc	significant intergranular flow – moderate productivity	%	
	inter_low_perc	significant intergranular flow – low productivity	%	
	frac_high_perc	flow through fractures – high productivity	%	
	frac_mod_perc	flow through fractures – moderate productivity	%	
	frac_low_perc	flow through fractures – low productivity	%	
	no_gw_perc	rocks with essentially no groundwater	%	
	low_nsig_perc	generally low productivity (intergranular flow) but some not significant aquifer	%	
	nsig_low_perc	generally not significant aquifer but some low productivity (intergranular flow)	%	
Hydrometry	station_type	gauging station type denoted by the following abbreviations (B Broad-crested weir; C Crump profile single-crest weir; CB Compound broad-crested weir; CC Compound Crump weir; EM Electromagnetic gauging station; EW Essex weir; FL Flume; FV Flat V triangular profile weir; IV Index Velocity; MIS Miscellaneous; TP Rectangular thin-plate weir; US Ultrasonic gauging station; VA Velocity-area gauging station; VN Triangular (V notch) thin-plate weir); XC Cross Correlation. Two abbreviations may be applied to each station relating to the measurement of low or high flows.	-	UK National River Flow Archive using the NRFA API*



	daily_flow_period_start	first date that daily flow time series provided in CAMELS-GB v2 is available for this gauging station	-	Catchment timeseries of daily streamflow described in Section 3.1.2
	daily_flow_period_end	end date that daily flow time series provided in CAMELS-GB v2 are available for this gauging station	-	
	daily_flow_percentage_complete	percentage of days with flow time series available from 1 st October 1970 – 31 st September 2022	%	
	hourly_flow_period_start	first date that hourly flow time series provided in CAMELS-GB v2 is available for this gauging station	-	Catchment timeseries of hourly streamflow described in Section 3.2.2
	hourly_flow_period_end	end date that hourly flow time series provided in CAMELS-GB v2 are available for this gauging station	-	
	hourly_flow_percentage_complete	percentage of hours with flow time series available from 1 st October 1990 09:00:00 – 1 st October 2022 08:00:00	%	
	bankfull_flow	flow at which the river begins to overlap the banks at a gauging station (obtained from stage-discharge relationships so may be derived by extrapolation)	$\text{m}^3 \text{s}^{-1}$	UK National River Flow Archive using the NRFA API*, catchment timeseries of streamflow described in Section 3.1.2 and 3.2.2
	structurefull_flow	flow at which the river begins to the wingwalls of a structure at a gauging station (obtained from stage-discharge relationships so may be derived by extrapolation)	$\text{m}^3 \text{s}^{-1}$	
	max_gauging_flow_date	date and time when the maximum gauging flow was taken	-	
	max_gauging_flow	the maximum gauging flow - the highest manual measurement of flow taken at a gauging station	$\text{m}^3 \text{s}^{-1}$	



	max_daily_flow	the maximum daily flow recorded in the daily flow time series times provided in CAMELS-GB v2	%	
	daily_flow_extrap_dur	the percentage of time (excluding NaNs) that the daily flow timeseries is higher than the maximum gauging flow	%	
	max_hourly_flow	the maximum hourly flow recorded in the hourly flow time series times provided in CAMELS-GB v2	%	
	hourly_flow_extrap_dur	the percentage of time (excluding NaNs) that the hourly flow timeseries is higher than the maximum gauging flow	%	
	qXX_uncert_upper	upper bound of the discharge uncertainty interval for the XX percentile flow given as a percentage of the XX percentile flow – estimates for XX values of 5, 25, 50, 75, 95, 99 are provided	%	
	qXX_uncert_lower	lower bound of the discharge uncertainty interval for the XX percentile flow given as a percentage of the XX percentile flow – estimates for XX values of 5, 25, 50, 75, 95, 99 are provided	%	
	quncert_meta	metadata describing the reasons why discharge uncertainty estimates are (not) provided; Calculated discharge uncertainties; No stage-discharge measurements available; Less than 20 stage-discharge measurements available for most recent rating; Discharge uncertainty estimates not provided as the estimated uncertainty bounds were deemed to not accurately reflect the discharge uncertainty or	-	Derived from Coxon et al (2015)



		because there was no sensible relationship between stage and discharge.		
Human Influence Attributes	benchmark_catch	benchmark catchment (Y indicates the catchment is part of the UK Benchmark Network, while N indicates that it is not)	Y/N	UK National River Flow Archive; Harrigan et al., (2018)
	surfacewater_abstractions	mean surface water abstraction	mm day ⁻¹	1 km × 1 km abstractions for multiple purposes (csv file) and 1 km × 1 km discharges for multiple purposes (RACT netcdf file) (Rameshwaran et al., 2025)
	groundwater_abstractions	mean groundwater abstraction	mm day ⁻¹	
	discharges	mean discharges (daily discharges into water courses from water companies and other discharge permit holders reported to the Environment Agency)	mm day ⁻¹	
	abs_agriculture_perc	percentage of total (groundwater and surface water) abstractions in catchment for agriculture	%	
	abs_amenities_perc	percentage of total (groundwater and surface water) abstractions in catchment for amenities	%	
	abs_energy_perc	percentage of total (groundwater and surface water) abstractions in catchment for energy production	%	
	abs_environmental_perc	percentage of total (groundwater and surface water) abstractions in catchment for environmental purposes	%	
	abs_industry_perc	percentage of total (groundwater and surface water) abstractions in catchment for industrial, commercial and public services	%	



	abs_watersupply_perc	percentage of total (groundwater and surface water) abstractions in catchment for water supply	%	
	abs_highloss_perc	percentage of total (groundwater and surface water) abstractions in catchment that is classified as 'high loss'	%	
	abs_mediumloss_perc	percentage of total (groundwater and surface water) abstractions in catchment that is classified as 'medium loss'	%	
	abs_lowloss_perc	percentage of total (groundwater and surface water) abstractions in catchment that is classified as 'low loss'	%	
	abs_verylowloss_perc	percentage of total (groundwater and surface water) abstractions in catchment that is classified as 'very low loss'	%	
	num_reservoir	number of reservoirs in the catchment	-	UK Reservoir Inventory (Durant and Counsell, 2018), SEPA's publicly available controlled reservoirs register (http://map.sepa.org.uk/reservoirsfloodmap/Map.htm , last access: 2 nd September, 2025) and Salwey et al., (2023)
	reservoir_cap	total storage capacity of reservoirs in the catchment in megalitres	ML	
	reservoir_contributing_area	percentage of the overall catchment surface area that is drained through reservoirs	%	
	reservoir_normalised_upstream_capacity	ratio of the capacity of a reservoir to the average volume of precipitation received by the catchment in a year	-	
	reservoir_he	percentage of total reservoir storage in catchment used for hydroelectricity	%	
	reservoir_nav	percentage of total reservoir storage in catchment used for navigation	%	
	reservoir_drain	percentage of total reservoir storage in catchment used for drainage	%	
	reservoir_wr	percentage of total reservoir storage in catchment used for water resources	%	



	reservoir_fs	percentage of total reservoir storage in catchment used for flood storage	%	
	reservoir_env	percentage of total reservoir storage in catchment used for environmental	%	
	reservoir_nouse data	percentage of total reservoir storage in catchment where no use data were available	%	
	reservoir_year_first	year the first reservoir in the catchment was built	-	
	reservoir_year_last	year the last reservoir in the catchment was built	-	
Groundwater Wells	gw_well_id	groundwater well identifier (corresponds to the ID provided by the British Geological Survey)	-	UK Hydrometric Register (Marsh and Hannaford, 2008)
	gw_well_name	groundwater well name	-	
	gw_well_easting	groundwater well easting	-	
	gw_well_northing	groundwater well northing	-	
	gw_well_datum	the altitude of the point from which measurements are taken at a particular site	mAOD	
	gw_well_depth	depth of the groundwater well	m	
	aquifer	aquifer to which the water level variations in the wells are attributed	-	
	daily_gwlevel_period_start	first date that daily groundwater level series provided in CAMELS-GB v2 is available for this groundwater well	-	Groundwater level timeseries described in Section 4.4
	daily_gwlevel_period_end	end date that daily groundwater level series provided in CAMELS-GB v2 is available for this groundwater well	-	



	daily_gwlevel_perc_complete	percentage of days with groundwater level data	-	
	monthly_gwlevel_period_start	first date that monthly groundwater level series provided in CAMELS-GB v2 is available for this groundwater well	-	
	monthly_gwlevel_period_end	end date that monthly groundwater level series provided in CAMELS-GB v2 is available for this groundwater well	-	
	monthly_gwlevel_perc_complete	percentage of months with groundwater level data	-	