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The newsletter of the British Hydrological Society



BHS membership

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Cover photo: New BHS logo

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Membership enquiries: Moira Doherty, BHS Secretary, Institution of Civil Engineers, 1-7 Great George Street, London, SW1P 3AA. Tel. 0207 665 2234. Email: moira.doherty@ice.org.uk

Editor: Vicky Shackle: bhs-circulation@outlook.com

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Please email your material to bhs-circulation@outlook.com — contributions may be edited for length or clarity (**maximum** 1,000 words, or 750 with figures). Hydrological photos very welcome.

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In between issues of Circulation, you can keep up with the **British Hydrological Society** on social media:

LinkedIn—search for British Hydrological Society

Bluesky @britishhydrosoc.bsky.social

President's perspective

Joe Pearce



As I take up the privilege of becoming BHS President, I must begin with great thanks to my predecessor **Duncan Faulkner** for all he has done over the past two years. Being welcomed to the Society Trustees committee over last year as President Elect, I've experienced the enthusiasm and support among the group for delivering our aims.

Under Duncan's guidance the Society's governance has strengthened, participation has broadened and firm foundations for the future have been established. It's easy to see the many ways in which the society is flourishing.

This year we are in a good place to progress and deliver current plans and activities which will help our members connect and develop. Our events and initiatives will continue to provide focus to develop, communicate and apply the science to our members and others in the UK and internationally. We'll seek to support members' development, whatever stage of career they are at, and continue to ensure we have the right governance in place.

We continue to develop the Society's governance, notably through increasing the number of Trustees elected to represent the Society at the AGM in September. We are immensely grateful to **Gemma Coxon , Will Rust** and **Katy Peat** who reached the end of their term as trustees, and are delighted to welcome five new Trustees, who are:

Geoff Darch, Anglian Water

Elena Konstanty, starting at a policy-focused think tank

Kevin Tilford, Weetwood

Annie Ockelford, Liverpool University

Ben Howard, Imperial College London

We have much to look forward to this year including meetings we are promoting nationally which will offer opportunities for meeting in-person, gathering to discuss and exchange ideas (see forthcoming events on p26). Please note these dates for your diary and plan to come if you can!

Geoff Darch, has taken over as the new chair of our Events sub-committee that leads in organising the programming and delivery, continuing the great work of Gemma Coxon.

In February 2026 we will hold our Professional Development Month, a new initiative working with other professional organisations to help members consider options for routes to chartership that can work with and complement BHS membership. **Emma Cross** has taken over from me as chair of our Education, Careers and Membership sub-committee and is leading this initiative.

Through this and other initiatives, we continue to work with other organisations. **Will Rust** organised our input to the recent meeting held jointly with the Royal Meteorological Society in London, *From Forecast to Action: Advancing Flash Flood Resilience.* This brought together speakers and audience representing researchers, forecasters, practitioners and policy makers to explore the issues and many challenges involved.

I was fortunate to be able to attend CIWEM's Rivers and Coastal Group study day visit to the new reservoir site currently being constructed at Havant Thicket in Hampshire earlier this month, the first among numerous planned new reservoirs.

We are pleased to see that our regional groups continue to gain strength, with activities planned and happening under the guidance of the regional representatives:

Ellen Broad - Pennines Hydrological Group (bhs_pennines@outlook.com)

Mark Wilkinson - Scottish Hydrological Group

Mike Simpson - Midlands Group (bhs_midlands@outlook.com)

Owain Sheppard, Freek van Arkel & others - Southwest England and Wales Group (bhs_southwest@outlook.com)

Clare Waller, Tracey Haxton – Southeast England Group (bhs_southeast@outlook.com)

These groups will give members more opportunities to meet and exchange ideas covering local issues and priorities. If you have ideas for local events or wish to host a meeting, please contact your regional organiser.

We look forward to the launch of our new BHS website incorporating our updated logo. The new website will afford us greater flexibility to adapt further changes as needed.

We welcome input from members and there is a wide variety of possible opportunities for involvement. This could be to offer support to one of our sub-committees, or perhaps help with organising or participating in regional or national events, or provide a contribution to Circulation on a topic of interest to our members.

Although I have maintained involvement with BHS over my 35 year career, attending events and on the South East organising committee, I haven't experienced the main committee since my role as Hon Secretary finished in 2006. My year as President Elect has highlighted for me the success of the Society bringing together people working and studying across hydrological disciplines, employment sectors and experience. I look forward to serving as President over the next two years.

The British Hydrological Society's new logo

As you will have seen on the front cover of this issue, our logo has been updated for the 21st Century. The water cycle theme has been kept, with a circle of arrows representing rainfall, runoff and groundwater movement, and evaporation. Within the circle there is a depiction of a landscape with a river and a cloudy sky.

The logo has been produced in a variety of colour and monochrome combinations, so there should be a version that works for whatever you are producing.



British Hydrological Society, student awards 2025

And the winners are...

Each year, BHS awards a prize for the best undergraduate dissertation(s) in hydrology, submitted by university departments. The aim is to raise the status of hydrological education in the UK, as well as to encourage hydrological study in civil engineering, environmental sciences and geography.

Submitted dissertations must be single-authored independent research projects, addressing scientific and/or applied issues in hydrology.

The judging panel (drawn from the main BHS committee) is delighted to announce this year's winners:

First prize is awarded to **Dylan Tweats of Durham University** for a dissertation entitled "*Assessing climate change impacts on nitrogen dynamics and eutrophication risk in the Upper Eden: a comparative evaluation of process-based, empirical and deep learning modelling approaches*"

The runners up are Katie Able of the University of Sheffield, with a dissertation entitled "*Assessing water quality in Lake Windermere Tributaries: a comparative study of anthropogenic impacts and seasonal variability*", and Alice Clarke of the University of Cambridge with a dissertation entitled "*Modelling bedrock overdeepenings and possible future glacier lakes in the Central Andes*".

Congratulations to all three winners! You can read a summary of Dylan's dissertation over the page.



Modelling architecture shapes future nitrogen pollution risk in UK catchments

Dylan Tweats, University of Durham

Structural uncertainty in predictive models may rival climate uncertainty as a driver of divergent water-quality forecasts. Working in Newby Beck, a headwater catchment of the Upper Eden in Cumbria, this study compared three modelling approaches – process-based (INCA-N), deep learning (LSTM-XGBoost hybrid) and statistical regression (MLR) – to simulate nitrogen dynamics under identical climate forcing to 2080. The findings expose how structural uncertainty – embedded in model design – actively reshapes environmental prediction, highlighting how models function as coagents in shaping water-quality futures.

By 2080, the deep learning model projected nitrate concentrations at 12.09 mg/L with 75% of days at high eutrophication risk. The process-based model projected 10.40 mg/L with 44% high-risk days. The regression model showed minimal change: 9.70 mg/L with just 7% high-risk days. These divergent trajectories emerge from the same climate data, revealing that modelling architecture fundamentally shapes our understanding of future water quality—not as neutral forecasting tools, but as active interpreters that amplify, dampen, or restructure environmental signals.

The study employed systematic sensitivity analysis, stress-testing each model by perturbing climate variables up to ±200% beyond observed ranges. This revealed distinct architectural behaviours invisible to standard validation metrics. The deep learning model, despite strong historical performance, exhibited escalating sensitivity after 2050. Its responsiveness to rainfall and temperature increased by 64-121%, not proportional to climate forcing but driven by structural amplification of training biases.

An anomalous 2012 drought-flush event, encoded in the model's memory structure, was progressively amplified under novel conditions. Without physical constraints like mass balance, the model's statistical flexibility became a pathway for compounding errors.

The regression model failed differently: structural rigidity prevented it from capturing threshold-driven dynamics. Despite calibration on data where storm events drive 60-80% of annual nutrient export, it maintained strictly linear responses. It reproduced historical patterns adequately but failed to represent the non-linear, event-driven processes that will govern future behaviour. This highlights a fundamental limitation of purely empirical approaches – fitting observations doesn't guarantee process representation.

Only INCA-N maintained process resilience – responses that intensified with climate forcing while remaining physically bounded. Its mass-conserving architecture and explicit biogeochemical representations constrained sensitivities even under extreme perturbations. The model wasn't without limitations – all three struggled with baseflow conditions – but INCA-N's failures were diagnosable and rooted in specific process simplifications rather than unconstrained statistical drift.

The ecological implications become apparent when nitrogen projections drive a risk framework integrating temperature, flow, dissolved oxygen, and biological productivity. Spring emerged as a period of compound vulnerability, where rising temperatures and biological reactivation coincide with winter rainfall-driven nitrate mobilisation. However, the magnitude and timing of this risk depended critically on model structure. By 2080, the deep learning model projected 31% of spring days exceeding high-risk thresholds compared to 17% for INCA-N – nearly double, despite identical environmental forcing.

Winter patterns revealed important constraints on risk expression. Despite elevated nitrate concentrations from increased rainfall, cold temperatures and biological dormancy suppressed eutrophication risk across all models. This demonstrates that ecological risk emerges from interactions between nutrient loading and environmental receptivity, not concentration alone. Models don't simply predict these interactions – they actively shape how we interpret when and where risk manifests.

The findings challenge conventional model evaluation practices. Nash-Sutcliffe Efficiency, RMSE, and KGE assess how well models reproduce historical observations but provide limited insight into structural behaviour under non-stationary conditions. Both the deep learning and process-based model's achieved similar baseline performances, however, exhibited fundamentally different sensitivities when forced beyond calibration domains. Flow-partitioned error analysis revealed that failure modes varied by hydrological phase, with all models struggling during baseflow but for different mechanistic reasons.

This research quantifies a rarely examined source of forecasting uncertainty: structural sensitivity embedded in modelling architectures. While climate scenario uncertainty receives extensive attention, the study demonstrates that uncertainty propagates equally from how models encode, constrain, and extrapolate system responses. This has immediate implications for water quality management, where models increasingly inform high-stakes decisions about intervention timing, resource allocation, and regulatory compliance.

For UK water management – where only 35% of waterbodies achieve good chemical status under Water Framework Directive standards – these findings emphasise that addressing diffuse nitrogen pollution under climate change

requires explicit acknowledgment of structural uncertainty. Single-model projections risk embedding architectural biases into policy frameworks.

The alternative is pluralistic modelling, where multiple architectural paradigms are systematically compared to bound uncertainty and diagnose where structural assumptions drive divergent projections. As deep learning expands in environmental forecasting, the study underscores that evaluation must extend beyond retrospective validation. Process resilience – the capacity to maintain physically credible dynamics under novel forcing – emerges as a critical but underutilised diagnostic. Models should be tested not just on how well they fit the past, but on whether their internal behaviours remain plausible when stressed beyond historical ranges. In non-stationary futures, credibility under novelty matters as much as accuracy under familiarity when attempting to provide assurance.



Developing a National Drought Modelling and Forecasting Framework for Scotland

Dr Shaini Naha, James Hutton Institute

Scotland has long been perceived as a water abundant nation. However, as climate change alters rainfall patterns and increases the frequency of dry spells, even water-rich regions are becoming more vulnerable. By mid-May 2025, the Scottish Environmental Protection Agency (SEPA) reported that all of Scotland remained at some level of water scarcity, with notable impacts in the Deveron, Dee, Ythan, and Don catchments, with ongoing abstraction restrictions in some regions and increasing risk of bans as dry conditions persist.

Such events highlight an urgent need to move from reactive drought management to proactive drought forecasting. Therefore, as part of the 'Emerging Water Futures: Understanding the vulnerabilities of Scotland's water resources to drought' research project funded by the Scottish Government RESAS Strategic Research Programme 2022-27, we are developing a national-scale drought modelling and forecasting framework for Scotland. The project integrates ensemble hydrological modelling, ensemble meteorological forecasts, and uncertainty quantification into one system designed to support SEPA's operational drought early warning and water scarcity management activities.

The hydrological multi-model framework captures both structural and parametric uncertainty which is a critical step in improving the reliability of hydrological predictions. We use two models of differing complexity: GR6J, a lumped conceptual rainfall–runoff model, and HYPE, a semi-distributed, process-based model that divides each catchment into unique Soil and Land Use combinations. This model combination allows us to represent both system simplicity and spatial process detail, improving robustness across Scottish catchments.

Both models were calibrated for 81 catchments within SEPA's Drought Risk Assessment Tool (DRAT) network. Calibration (2010–2015) and validation (2016–2021) were conducted using a multi-objective optimisation approach based on two performance metrics: the Kling–Gupta Efficiency (KGE), representing overall hydrological agreement, and the log-transformed Nash–Sutcliffe Efficiency (logNSE), assessing model skill in reproducing low flows, critical for drought analysis. Both models showed robust performance across diverse catchment sizes, with median KGE values ranging from 0.36 to 0.96 and logNSE from 0.30 to 0.94 across the calibration and validation period. GR6J consistently performed better in simulating low flows, with natural and near-natural catchments such as the Almond, Ugie, and Eden showing the best-performing results.

To evaluate forecasting ability, the calibrated models were integrated with ensemble mean rainfall and temperature forecasts from the European Centre for Medium-Range Weather Forecasts (ECMWF). Using the 15-day ensemble prediction system for 2023, we performed a hindcasting experiment to simulate real-time forecasts under historical conditions. Each ECMWF forecast comprises 50 ensemble members, allowing the representation of inherent meteorological uncertainty and its propagation into hydrological responses. The ensemble mean rain forecasts were first evaluated against HadUK-Grid observations to assess skill across different lead times. As expected, rainfall forecast skill declined progressively with increasing lead time (0–15 days), while ensemble spread (standard deviation across members) increased, indicating



growing forecast uncertainty that would propagate into streamflow forecasts.

The GR6J model driven by ensemble mean forecasts at a 0-day lead time demonstrated very good streamflow forecast skill, closely matching observations at the DRAT stations. Across all catchments, median KGE values ranged from 0.02 to 0.84, while logNSE values ranged from –1.0 to 0.81, with around 60 catchments achieving skill scores above 0.5. Testing at longer lead times (up to 15 days) and with the full set of 50 ensemble members, is ongoing.

Looking ahead, statistical post-processing techniques such as bias correction will be applied to streamflow forecasts to enhance their accuracy and reliability. In the next phase, the research team will focus on developing a probabilistic framework for identifying severe hydrological drought events, and a low flow forecasting tool to support an early warning system across all DRAT catchments in Scotland. These tools will be made accessible to SEPA, facilitating the operational use of forecast information during periods of water scarcity. Probabilistic forecasts are particularly valuable for decision-making under uncertainty, enabling stakeholders to assess risk and plan adaptively.

I would like to thank the BHS Exeter Fund Grant for supporting my travel to IAHS2025 in Roorkee, India, to present this research.

Research team: *Shaini Naha[1]*, Zisis Gagkas[1], Nick Schurch[2], Hossein Abbasizadeh[3], Johan Strömqvist[4], Alena Bartosova[4], Jethro Browell[5] and Miriam Glendell[1]*

Email: shaini.naha@hutton.ac.uk

1.The James Hutton Institute, UK. 2. Biomathematics and Statistics Scotland, UK. 3. Faculty of Environmental Sciences, Czech University of Life Sciences Prague, Czech Republic. 4. Swedish Meteorological and Hydrological Institute, Sweden. 5. School of Mathematics & Statistics, University of Glasgow, UK.

Inaugural South West & Wales BHS Regional Group meeting

Freek van Arkel

Around 35 people attended the first meeting of the relaunched South West and Wales regional group in Bristol on the 24th September, to hear two excellent talks that sparked interesting discussion.

The first presentation was given by **Dr Francesca Pianosi** on the topic of uncertainties in hydrology and water resources modelling. Francesca delivered a thought-provoking lecture showing how uncertainties affect model outputs and how they can be assessed systematically. She explained that every model parameter can be varied separately to produce a distribution of its influence on results. These distribution curves can then be used to rank parameters, identifying which ones have the greatest impact. This forms the basis of Global Sensitivity Analysis (GSA), a powerful tool for exploring how uncertainties propagate through models and for prioritising where improvements should be made. Drawing on recent case studies, Francesca demonstrated how GSA can support both developers and end-users of hydrological models, helping them better understand and communicate the implications of uncertainty.

The second presentation was delivered by **Mr Benjamin Evans** and focused on the application of QUBE's new climate change functionality. Ben compared climate-adjusted inflows generated by QUBE with those produced by Welsh Water's calibrated models. The analysis showed that QUBE's results were broadly consistent with Welsh Water's modelling, although some differences were evident at the upper and lower ends of the flow predictions. Ben emphasised how the new QUBE functionality makes it far easier and quicker to generate inflows under UKCP18 climate change scenarios, offering clear benefits for future water resources modelling in

Wales and across the UK.

Overall, the event was a great success. **Owain Sheppard** gave an introduction to the aims of the new group and outlined plans for future events, and **Miquel Rico-Ramirez** ensured everyone was well looked after with great food as well as organising the venue at the University of Bristol. The evening finished with networking and further conversations at the local pub; a fitting end to the first of what promises to be many engaging and valuable meetings for the region.

To support the continued success of the South West and Wales group we invite those located in these regions to fill in the survey using the QR code.

BHS is delighted to announce our **Professional Development Month for Hydrologists.** Save the date! February 2026.

Thinking about your professional development as a hydrologist in 2026? Join us online every Wednesday in February at 13:00 to explore chartership!

We'll be considering what chartership means for a hydrologist and why is it important, as well as the benefits of chartership, how to become chartered, and what routes are available.

Whatever career stage you're at, these sessions will help you understand your options, help you invest in your personal development, expand your network and gain professional recognition as a hydrologist.

Booking available in the New Year. In the meantime, keep an eye on the BHS mailing list emails and social media channels for more information.

Questions? email the careers and education committee at *bhs_education@outlook.com*

Connecting the UK hydrological community to the world: BHS and IAHS

Professor Christopher White, University of Strathclyde

Did you know that the BHS is your gateway to the global hydrology community? Through its long-standing partnership with the International Association of Hydrological Sciences (IAHS), UK hydrologists have a direct line to international collaboration, cutting-edge research and opportunities to shape the future of water science.

What is the IAHS?

The IAHS is a non-profit, non-governmental scientific organisation and is one of the oldest associations of the International Union of Geodesy and Geophysics (IUGG). With over 12,000 members across 150 countries, IAHS is a truly global network run by hydrologists, for hydrologists. Membership is free and is open to anyone working in hydrology, whether your focus is rivers, groundwater, hydrology-atmosphere interactions, snow and ice, sediment transport, or water resource management.

IAHS has a vision of inclusive scientific knowledge exchange in hydrology for sustainable development in a changing world. It promotes hydrology as a vital earth science, supporting international research collaboration and providing platforms for publishing and sharing knowledge. Its activities are driven by multiple specialist Commissions and various Working Groups, including the current HELPING (Hydrology Engaging Local People IN one Global world) science for water solutions decade; these organise conferences, workshops, and the flagship IAHS Scientific Assembly held every four years, hosted this year by IIT Roorkee, India, that saw a large number of UK hydrologists attend. The IAHS even has its own publication, the Hydrological Sciences Journal (HSJ).

The UK connection

The UK's link to IAHS is coordinated by the BHS Committee through the UK IAHS Representative, Prof Christopher J. White, who is also the President of the IAHS Coupled Land-Atmosphere Systems (ICCLAS) Commission. The IAHS UK Representative supports the representation of UK hydrologists in the IAHS, facilitates nominations for awards and leadership roles, and promotes UK involvement in IAHS initiatives. The role also manages the Exeter Travel Fund, which supports BHS members – especially early career hydrologists – in attending IAHS and IUGG Assemblies. This fund was established from the legacy of the first IAHS Scientific Assembly held in Exeter in 1982.

IAHS offers a unique opportunity to connect UK hydrology with global science, whether you're an academic, practitioner or student. If you're interested in learning more about the IAHS, one of the Commissions or the HELPING decade, or are interested in linking with other UK-based IAHS members, please visit https://iahs.info/ or feel free to contact me, Prof Christopher White: chris.white@strath.ac.uk.

Sign up to IAHS here: https://iahs.info/Members-Area/register/



Major update to the National River Flow Archive (NRFA) datasets

Gayatri Suman, UKCEH

The National River Flow Archive (NRFA) has released a significant update to its holdings, including:

- Daily Mean and Peak Flow Data for 2023-24 water year
- Version 14 of the National Peak Flow Dataset
- Updated Catchment Daily Rainfall Dataset, now extended to 2023

The 2023/2024 water year was defined by extreme weather, including 12 named storms – the highest number since the naming system began in 2015. Notably, Storm Babet in October 2023 brought intense rainfall and severe flooding to northeast England and much of Scotland, triggering two rare red weather warnings for rain. The October–March period was the wettest winter half-year ever recorded for England, resulting in sustained high flows on major rivers such as the Trent, Warwickshire Avon, Tywi, Ythan, and Exe.

Daily Mean Flow Data

Quality-controlled daily mean flow data are now available for most UK gauging stations up to 30 September 2024. The update reveals new record high and low river flows at several locations (Figure 1).



Figure 1: Gauging stations with record high or low daily mean flows in the 2023/2024 water year

Peak Flow Data

The updated national Peak Flow Dataset (version 14) provides flood estimation data for 926 UK gauging stations. Used in conjunction with WINFAP software and the Flood Estimation Handbook (FEH) methods, the dataset contains Annual Maxima (AMAX) and Peaks Over Threshold (POT) data Stations are classified by hydrometric quality: 552 "Suitable for Pooling," 350 "Suitable for QMED only," and 24 "Suitable for Neither."

During the 2023/2024 water year, 51 stations in Scotland, England and Northern Ireland recorded new AMAX1 records (see Figure 2).



Figure 2: Gauging stations with new record AMAX1 data in the 2023/2024 water year

As well as the additional water year of peak flow data, an extensive review of period of record flow and stage data, gaugings, ratings and associated metadata (e.g. POT threshold, station description, rating history, missing data periods, FEH Indicative Suitability, rejected years) was undertaken for 81 stations (11 in Scotland, 47 in England, nine in Wales and 14 in Northern Ireland).

In Wales, bankfull and structurefull levels were reviewed, alongside investigations into pre-digital rating holdings in the NRFA's physical archive – results were fed back to Natural Resources Wales (NRW). For England, AMAX comments for all Peak Flow stations were reviewed.

The national Peak Flow Dataset is maintained as an integral part of the NRFA by the UK Centre for Ecology & Hydrology in collaboration with the Environment Agency, NRW, Northern Ireland's Department for Infrastructure – Rivers Directorate, and SEPA. It is conservatively estimated to save £5.4 million annually in costs for regulators and consultants.

Catchment Daily Rainfall Data

NRFA has also overhauled the Catchment Daily Rainfall dataset, updating it using the Met Office HadUK-Grid data, spanning from the start of station flow records to 2023. This replaces the previous CEH-GEAR version and introduces methodological changes. As the datasets are now not directly compatible, users should use the new dataset, available via station daily flow pages. We aim to update the Catchment Daily Rainfall annually, following the release of each final quality-controlled Met Office HadUK-Grid dataset.

More information can be found on the NRFA Website: https://nrfa.ceh.ac.uk/news-and-media.

***Gayatri Suman**, National River Flow Archive, UK Centre for Ecology & Hydrology*



Gauge 50005, West Okement at Vellake

Throwing out the Flood Estimation Handbook?

Anthony Hammond, JBA Consulting

Perhaps the actual title should be 'Should we stop trying to estimate the T-year flood?', but if the answer to that question is yes, then perhaps there would be little need for the FEH (or at least large parts of it).

The T-year flood is associated with a return period of T years. Flood management practitioners are commonly required to estimate the peak discharge and hydrograph shape of the T-year flood, and the Flood Estimation Handbook (and associated updates) is the standard guidance for doing so.

The uncertainty associated with extreme rainfall estimation is widely considered to be significantly less than that of flood peak estimation. Instead of attempting to estimate the T-year flow, perhaps the aim could be to consider a range of plausible outcomes given the T-year rainfall.

Instead of "what is the T-year flood?" the question being posed would be: "what is a plausible range of outcomes from a T-year rainfall event?" For fluvial flooding, stochastic event -based rainfall runoff modelling could be applied with a range of initial conditions, a range of different temporal (and perhaps spatial) rainfall profiles, with a range of durations.

UK Climate change allowances are provided as percentiles, and different percentiles are used depending on the purpose of the study and the associated appetite for risk. This approach could also be applied for flood risk management in general, including for flood hazard mapping.

However, there is a possible legislative barrier. The Flood Risk Regulations 2009 (part 3 sections 18 and 20) states that it is the regulatory bodies' duty to prepare flood hazard maps along with details of whether the probability of the flood occurring is low, medium, or high.

It further defines 'low' as "if the chances of it occurring in any 12 month period are 0.1% or less", 'medium' as "if the chances of it occurring in any 12 month period are more than 0.1% but not more than 1%", and 'high' as "if the chances of it occurring in any 12 month period are more than 1%".

However, a distribution of maps (or the central extents) given these probabilities - but associated with the rainfall - may be satisfactory to fulfil the specified duty. If not, a significant barrier to the application of this idea would be the necessity to change legislation.

As a practical example of this idea the ReFH2.3 model was run for an ungauged catchment in the town of Ibstock, on an unnamed tributary to the River Sence. It was run 200 times for the 1%AEP event (100-year return period) (Figure 1). Each time, a different rainfall temporal profile was chosen (all 8.25 hours), the rainfall depths were sampled from a plausible range associated with the FEH22 estimates, and the parameters Cmax, BL, BR, and TP were sampled from their sampling distribution. The initial conditions, Cini and BF0, were also uniformly sampled from a plausible range.

Parameters: these were sampled using Equation 1, where P stands for the parameter of interest and the subscripts s, c, and FSE, stand for a sampled value, the central estimate, and the factorial standard error, respectively (N denotes a normal distribution). The factorial standard errors for the parameters were taken from Table 3 of the ReFH2.3 Wallingford Hydro-solutions report[1] and the central parameter estimates were derived from the ReFH2.3 software.

Equation 1 $$P_s = \exp[N(ln(P_c), ln(P_{FSE}))]$$

[1] WHS (2019) ReFH2 Science Report: Model Parameters and Initial Conditions for Ungauged Catchments. Wallingford.

Initial conditions: sampling was done uniformly from a plausible range. For initial baseflow (BF0) a mean flow was calculated considering a water balance (Equation 2), where the change in storage is assumed to even out to zero over the long term. The average annual rainfall was derived from a Met Office 1991-2020 HadUK grid and the net rain was derived by subtracting the average annual evapotranspiration (calculated as average annual PET multiplied by 0.9).

Equation 2 $$\bar{q}\ (m^3/s) = \frac{Area\ (m^2) \cdot Annual\ Net\ Rain\ (m)}{Seconds\ in\ a\ year}$$

Then a winter to summer average range was derived by multiplying the result by 1.6 and 0.5, respectively[2].

The sampling range for the initial soil moisture (Cini) was based on the initial estimate from the ReFH2.3 software, then the lower and upper end were derived as ± 30% of this initial estimate. Such sampling could be weighted according to seasonality assumptions.

Rainfall depths: sampled uniformly between the winter adjusted 1%AEP depth and the summer adjusted 1%AEP depth (48mm to 72mm) – again this could be weighted based on seasonality assumptions. Or alternatively, sampled from the rainfall uncertainty in the same way as for the parameters (i.e. Equation 1), with FSE derived from local records.

Rainfall temporal profiles: could be derived by sampling from a nearby gauge for the duration of interest, then scaled to the depths required for each run (i.e. P = {P/sum(P)} * Depth). However, in this case the profiles were generated randomly using an exponential distribution (for each pulse), but set to generate front, uniform, middle, and back loaded profiles at random. These were scaled to sum to unity and multiplied by the selected depth.

[2] Average coefficients for winter/summer annual mean flows across 1,600 NRFA sites

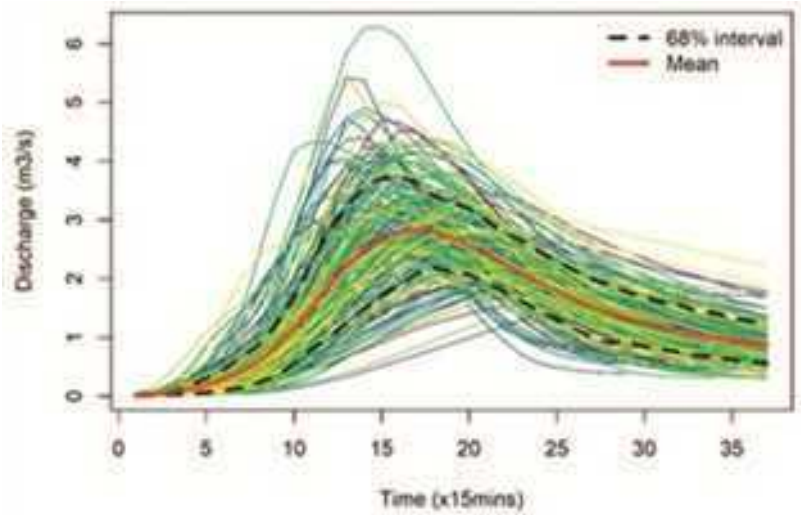


Figure 1: 200 hydrographs derived during the analysis

This approach naturally provides a range of outputs from which uncertainty can be quantified and illustrated.

It would also be useful to undertake the process with multiple rainfall-runoff models (or combinations of model components) to incorporate some of the uncertainty associated with model structure and associated assumptions. Ideally this would come with a model rejection criterion which could also act as a quantification of our confidence in the models and a useful way to weight the associated results across the models[3].

Approaches such as this have the benefit of addressing the uncertainty of flood estimation by making it a fundamental component of the modelling process.

For full details of the statistical analysis, please contact Anthony at anthony.hammond@jbaconsulting.com

{3] See Rainfall-Runoff Modelling: The Primer (2012), K.Beven, Wiley

Flood and Drought Research Infrastructure - large scale hydrological datasets released

We are pleased to share the release of **UKFlow15** and **CAMELSGBv2** datasets, providing open-access large scale, catchment-level and near real-time hydrological data to support hydrological modelling.

FDRI
FLOODS & DROUGHTS
RESEARCH INFRASTRUCTURE

These datasets were a collaboration between environmental agencies and researchers, enabled through FDRI.

You can find out more using these links, or the QR codes:

To access the new data: https://fdri.org.uk/news/new-hydrology-datasets-Flow15-CAMELSGBv2

To see a video about the work of our new catchment champions, appointed to lead engagement on monitoring designs within the three FDRI catchments: https://fdri.org.uk/news/new-catchment-champions

For further updates, please sign up to the FDRI newsletter here: https://mailchi.mp/ceh.ac.uk/fdri-sign-up

FDRI new datasets

Catchment champions

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NRFA top ten—an occasional series

Data extracted by Anthony Hammond, JBA Consulting

In keeping with the low rainfall across the UK this year, here are the ten catchments with the lowest SAAR values in the NRFA dataset. For comparison, the annual average UK rainfall (observed) is around 1,080mm.



Ten driest UK catchments, by SAAR 1961-1990

1. Shep at Fowlmere One, **541mm**
2. St Osyth Brook at Main Bridge Road, **544mm**
3. Bentley Brook at Saltwater Bridge, **550mm**
4. Sixpenny Brook at Ship House Bridge, **554mm**
5. Holland Brook at Thorpe le Soken, **555mm**
6. Eastwood Brook at Eastwood, **555mm**
7. Tenpenny Brook at Tenpenny Bridge, **556mm**
8. Rhee at Wimpole, **558mm**
9. Whaddon Brook at Whaddon, **558mm**
10. Rhee at Burnt Mill, **559mm**

Save the date:

BHS Fifth International Conference

taking place at

University of Leeds (hosted by water@leeds)

2nd to 4th September 2026



Save the date for BHS's first Symposium in Yorkshire since the 1980s!

Abstract submission opens **2 February 2026,** closes **2 April 2026**

Registration opens **2 March 2026,** closes **1 June 2026**

Successful authors notified **5 May 2026**

For more information please email *bhs_events@outlook.com*

Forthcoming events

A Fresh Water Future CIWEM conference, at 30 Euston Square, London on **2nd December 2025**. Aiming to build a more granular picture of how we quickly move from principles and concepts to mainstreamed delivery of a healthier and more resilient water environment. Register at https://www.ciwemevents.com/event/afwf/summary?RefId=Wesbite

CIWEM's Presidential Debate (in person) at Draper's Hall, London on **8th December 2025**, 11am-4.30pm. A structured debate chaired by the new President, John Curtin and featuring a cross-party selection of members of the House of Lords. Information and registration at https://www.ciwemevents.com/event/CIWEMPresidentialdebates/summary

UNESCO IMRR & SIMR webinar (virtual event) on 10th December 2025, 1pm-2pm. "Are we ready for the storms ahead?" by Prof Hayley Fowler. Registration: https://www.lboro.ac.uk/departments/abce/unesco-chair/events/webinar-series/2025/10-december-hayley-fowler

Stratospheric Influences on Surface Weather and Climate (in person and virtual) at Augustine United Church, Edinburgh on **20th January 2026**, 6.10-7.10pm. A talk by Dr Simon Lee, University of St Andrews. Register at https://www.rmets.org/event/stratospheric-influences-surface-weather-and-climate

Field Observations of Easter Weather on Snowdon from 1969 to 2010 (in person only) at University of Birmingham on **12th February 2026**, 4-5pm. A talk by Prof. David Bowers, School of Ocean Sciences, Bangor University. Register at https://www.rmets.org/event/field-observations-easter-weather-snowdon-1969-2010

Masterclass: Comparing the UK's Hot, Dry Summers of 2025 and 1976 (virtual) on **25th February 2026**, 3-4.30pm. A talk by Laura Baker, University of Reading. Register at https://www.rmets.org/event/masterclass-comparing-uks-hot-dry-summers-2025-and-1976

CIWEM Rivers and Coastal Group Technical Conference 2026, Arcadis office, Fenchurch Street, London on **6th March 2026**, 9am-5pm. A dynamic programme with presentations, panel discussions, and interactive workshops, designed to foster collaboration and spark insightful conversations. CIWEM members and non-members are welcome. Information and registration at https://www.ciwemevents.com/event/rcg/summary

Flood & Coast 2026, Liverpool Exhibition Centre **9-11th June 2026**, 9am-5pm. Flood & Coast is the UK's leading annual event for professionals working to manage flood risk, build climate resilience, and protect society and the environment. Information and registration at https://www.ciwemevents.com/event/floodandcoast/summary

Watch this space: plans are in progress for the BHS fifth International Conference, at the University of Leeds 2-4 September 2026 (see p29).

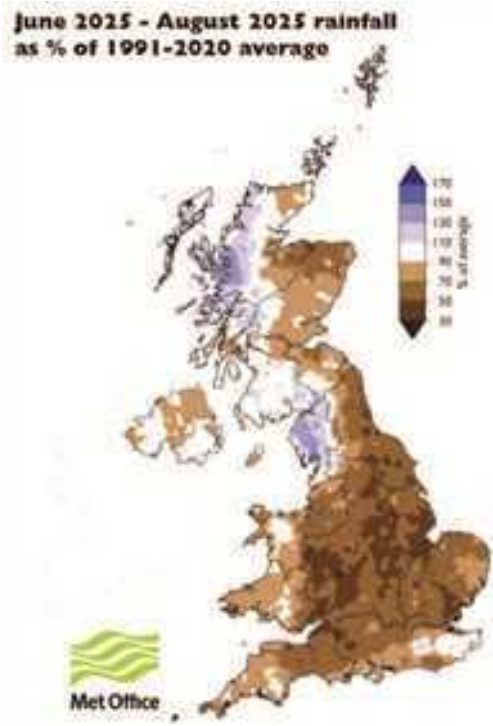
UK Hydrological Bulletin, August-October 2025

Compiled from UKCEH summaries

Although bookended by unsettled conditions, August rainfall was below average for the UK and high temperatures mid-month (11th-15th) contributed to warmer than average conditions overall. August caps a hot, dry summer; the warmest June-August on record for the UK since 1884. River flows were in the normal range in western Scotland and the far southeast of England but widely below normal and notably low elsewhere. Drought impacts were extensive – low flows caused ecological stress (fish mortalities), and dry soils reduced crop yields and exacerbated wildfires (e.g. North Yorkshire Moors). Widespread hands-off flow restrictions affected agriculture whilst navigation was heavily impacted by canal closures and restrictions. Reservoir stocks declined nationally and were >30% below average at Derwent Valley (Severn Trent), Washburn (Yorkshire), Elan Valley (Wales) and Ardingly (West Sussex); some (e.g. East Lothian, Washburn and Bristol) registered new August minima. Groundwater levels fell across the UK with exceptionally low levels in some southern and eastern boreholes but remained above normal in north Wales and central England. Drought status was declared for south-east Wales on the 14th, north Wales on the 29th and remained in place for north-west England, the Midlands and Yorkshire (where drought permit applications have been made).

"Significant water scarcity" was issued for parts of eastern Scotland on the 28th. The latest Hydrological Outlook suggests normal to above normal autumn flows in the north-west but continued below normal flows across southern and eastern areas. September started with welcome rainfall that eased some pressures on agriculture but sustained wet weather over autumn and winter, a crucial period for

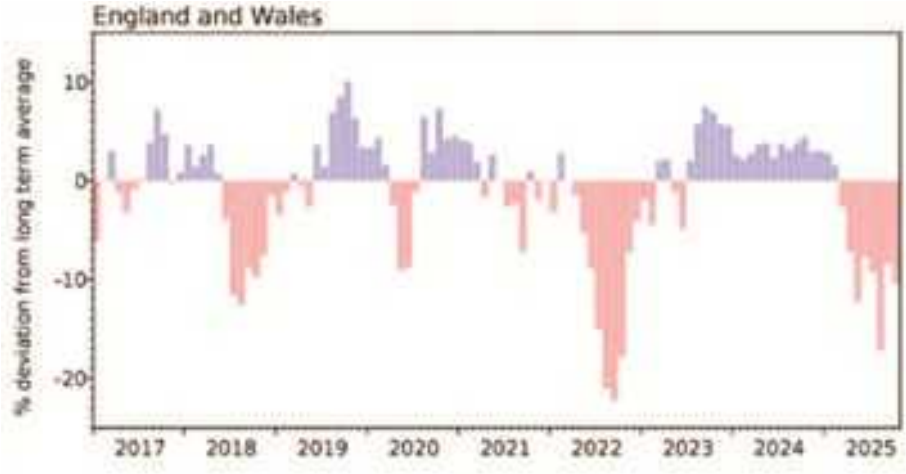
replenishing water resources, will be necessary to reverse deficits established through 2025.



In comparison to the summer months, September was wetter with temperatures nearer average. Rainfall was 132% of average for the UK, with most regions above average. River flows were above normal to exceptionally high in Northern Ireland, Wales and northern and south-west England, whilst below normal to exceptionally low flows were seen in northern and eastern Scotland and south-eastern England. Though soils wetted in all regions, COSMOS-UK sites in south-east England remained drier than normal at month-end. Groundwater levels generally remained below normal across the UK and continued to decline apart from western boreholes where some localised recharge was observed. In most impoundments, stocks rose relative to average and in some cases, stocks increased to above average by month-end (notably so at Northern Command Zone, Daer, Silent Valley). However, reservoirs from north-east Scotland to southern England remained below average at month-end – some substantially so, including East Lothian (its lowest for September in a series from 1988). Despite recent wetter conditions, the impacts of the dry spring/summer persist, with sustained rainfall still needed to fully recover the deficits that have built up since the start of the year.

At the end of September, five Environment Agency areas remained in drought and seven catchments in north-east Scotland remained at significant water scarcity; whilst by the 26th, all areas in Wales were in recovery from drought/ prolonged dry weather. The latest Hydrological Outlook suggests a continuation of normal to below normal flows and groundwater levels in eastern Scotland and the south and east of England, whilst elsewhere they are likely to be normal to above normal over the next three months.

October brought mixed conditions: a spell of high pressure and persistent cloud ("anticyclonic gloom") was framed by wet and windy periods. UK rainfall was near average overall, but this masked contrasts: totals were above average in Northern Ireland, western Scotland, and the far south-east of England, but widely below average elsewhere. River flows remained below normal in eastern Britain and southern England, and exceptionally low in parts of the Cotswolds and East Anglia. Elsewhere, they were generally normal, with some rivers above normal in Northern Ireland and western Scotland. Soils continued to wet up across the country, and soil moisture deficits in most northern and western areas



Overall reservoir stocks for England and Wales, 2017-2025

were eliminated. Groundwater levels were below normal to exceptionally low across central and northern Scotland, the east coast of Britain and southern England. Localised recharge occurred in Northern Ireland and along the west coast of Britain following recent wet conditions, but levels elsewhere continued to decline. Reservoir stocks rose slightly overall but remained below average for the time of year (e.g. Wimbleball, Ardingly and East Lothian were all 35% below average or more). The Hydrological Outlook indicates normal to below normal flows in eastern Scotland and southern and eastern England over the next three months, with particularly low flows expected in groundwater-fed rivers. Elsewhere, flows are likely to be normal to above normal. Despite a wetter than average start to November for many, if winter rainfall as a whole is below average, low flows will persist into 2026, limiting groundwater recharge, and delaying recovery before the spring and summer, particularly in south-east England.

The Hydrological Bulletins draw primarily on data and information from the UK Met Office and the CEH/BGS National Hydrological Monitoring Programme—the latter comprising data supplied by the Environment Agency, SEPA, NRW and Northern Ireland Environment Agency, as well as the UK water companies.



British Hydrological Society