Circulation

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The newsletter of the British Hydrological Society



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Cover photo: Swaledale near Muker, Yorkshire (Vicky Shackle)

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Copy deadline for Circulation 162 is 27th October 2024.
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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UK Hydrological Bulletin, May-July 2024

In between issues of Circulation, you can keep up with the **British Hydrological Society** on LinkedIn and X (formerly Twitter):

LinkedIn—search for British Hydrological Society

@britishhydrosoc

President's perspective

Duncan Faulkner

This month marks 20 years since the Boscastle flood, in which bridges, walls and 50 cars were swept out into a Cornish harbour following 75mm of rain in 2 hours. Thanks to an impressive rescue operation, no-one was killed. One consequence was an initiative to identify rapid response catchments and develop action plans for flood warning.

Those plans have been tested on many occasions since. We heard about more recent flash floods during June's Royal Society Science+ meeting: *Hydrology in the 21st century: challenges in science, to policy and practice*. Speakers, including Hayley Fowler, described how the climate crisis is playing out more quickly, and impacting hydrological systems more dramatically, than most models predicted it would. The 2021 Ahr Valley floods in Germany killed over 100 people in a fairly rural area. Paul Davies, the Met Office's Chief Meteorologist, warned that a storm of that severity will happen sometime in a UK city. We need to be ready. There's a worrying lack of action, on both mitigation and adaptation.

Other messages I took home from the meeting included the potential for physics-based modelling to play a greater role in hydrology, at scales from local to global. There are huge modelling resources available, yet many hydrologists are still operating like artisan craft workers in the pre-industrial age (in the words of Simon Dadson). At the same time, AI and ML have a vital role to play (Louise Slater spoke on this). These two modelling approaches are not mutually exclusive. Physics-informed ML models are emerging; ML can be trained on climate model output; explainable AI can open up the black box.

I came home from London encouraged that there's so much good science, so many gifted communicators, so much

potential for interesting work that makes a difference. Many thanks to Hayley and her team who led the organising of this high-profile event. Hayley has now come to the end of a four -year stint as a BHS trustee, with two years as President, and BHS has benefitted greatly from her dedication. Thank you also to the other trustees who have reached the end of their terms: Chris Skinner, who led the review of governance and the communications committee; Giuseppe Degan Di Dieco, our enthusiastic early career rep, and Anita Asadullah who has represented the Environment Agency and supported our work on education and careers.

Following in their footsteps is a new generation of trustees. Thank you to all who have agreed to be nominated, including several current officers willing to continue for a second term. We will introduce the new trustees at the AGM, to be held during the Symposium at Oxford on 24 September. If you are unable to get there, please do join the AGM online. It is a vital part of the governance of the Society; an opportunity for the trustees to be accountable to the members.

Speaking of next generations, an important role for BHS is supporting people into hydrological careers. Universities are currently having difficulties recruiting enough students to hydrology-related Masters courses. BHS will continue to run a studentship scheme with the support of JBA Trust. At the AGM we'll be asking members to vote on a proposal to increase our membership fees, to provide more financial support via these studentships.

Perhaps the central role for BHS, is to support the professional development of hydrologists. The Symposium provides a fantastic opportunity for hydrologists from all sectors and of all specialisms to get together, learn from each other and be inspired. I'm really looking forward to it and hope to see many of you in Oxford next month.

Communicating flood risk using words is probably less confusing than using probabilities (confused yet)?

Thomas Rodding Kjeldsen — Department of Architecture and Civil Engineering, University of Bath, UK

The concept of a return period underpins traditional flood frequency analysis and has served the hydrology community well since it was introduced more than a century ago. As a recap, assume you are using an annual maximum peak flow (AMAX) series and that there is a fixed annual probability p of exceeding a certain flood magnitude x_p and thus a probability ($1-p$) of not exceeding x_p in the same year. Then the probability of having to wait exactly n years (the recurrence interval) before the arrival of a big flood exceeding x_p can be described as the unique situation of observing $n-1$ years with no flood (AMAX<x_p) followed by a year where a flood exceeds x_p (AMAX > x_p). This combined probability is defined as:

$$\text{Probability of waiting } n \text{ years before exceeding } x_p = \underbrace{(1-p)\times(1-p)\times\cdots\times(1-p)}_{n-1 \text{ non-exceedance terms}}\times p$$

Trouble is, this relationship in itself does not allow us to calculate a design flood just yet; one more step is required. The mean value of the waiting time n can be found to be:

$$\text{mean waiting time between exceedances of } x_p = \frac{1}{p}$$

which is normally referred to as the return period $T=1/p$ (measured in years). So, the return period is the mean (or average) waiting time between exceedances of x_p (the design flood with annual exceedance probability p). Confused yet? This is complicated, and no wonder lay-people often confuse return period with a fixed waiting time between events, rather than the mean value of a statistical distribution of possible waiting times.

On top, all of this assumes independence between years and no change in the annual exceedance probability (AEP), which is incompatible with projected impacts of climate change. So return period is already a simplified and somewhat misleading way to quantify and communicate a highly uncertain phenomenon.

It is probably better to communicate flood risk as the AEP p rather than a return period. At least the AEP implies an ongoing risk rather than a fixed waiting time. But communicating probabilities and uncertainty to a general audience is also difficult. For example, use of precise numbers (such as return periods or AEPs) might give the impression of great confidence in the results. But we know that estimates of design floods are highly uncertain. We could communicate results as a range of possible values. But experiences from other science disciplines such as environmental health and medicine have shown that when people are presented with a range of values they often perceive the worst case as the most likely. Also, communicating a range of possible values could be perceived as a sign of incompetence or a deliberate attempt to confuse.

Hydrology is not alone in dealing with and communicating highly uncertain information. Some disciplines rely much more on a verbal description of risk and probability than hydrology. For example, during the cold war an experiment was conducted[1] by asking 23 NATO intelligence analysts to assign a probability to verbal statements on the likelihood of a Soviet invasion of the then Czechoslovakia such as: "It is highly likely that the Soviets will invade Czechoslovakia," or "It is almost certain that the Soviets will invade Czechoslovakia," or “We believe that the Soviets will invade Czechoslovakia”. The basic structure of all sentences remained constant; only the-verbal qualifiers changed.

1. Barclay, S. 1977. Handbook for decision analysis. Technical Report TR-77-6-30

The experiment showed notable variation in interpreting how these statements translated into probability of invasion, even among seasoned professionals. Consequently it is now accepted practice to use a probability yardstick in security analysis (Figure 1, adapted from PHIA[2]).

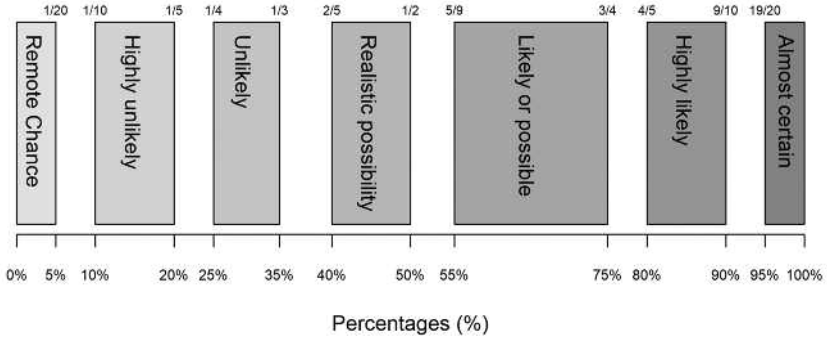


Figure 1: The Probability Yardstick (adopted from PHIA, 2019)

Some institutions now provide guidelines for how to use language to reflect risk and uncertainty. The IPCC (2005) recommend classification as in Table 1 when discussing climate change impacts. The National Institute for Health & Care Excellence (NICE) recommends a similar system for communicating estimated likelihood of side effects on medicine packaging (probability as 1 in X persons) (Table 2).

Terminology	Likelihood	Return period (years)
Virtually certain	More than 0.99 probability	1.01
Very likely	More than 0.90 probability	1.11
Likely	More than 0.60 probability	1.67
About as likely as not	0.33 – 0.66 Probability	1.51 – 3.01
Unlikely	Less than 0.33 probability	3.01
Very unlikely	Less than 0.10 probability	10
Exceptionally unlikely	Less than 0.01 Probability	100

Table 1: IPCC (2005) proposed translation between verbal and numerical probabilities

2. Professional Head of Intelligence Assessment, 2019. Professional Development Framework for all-source intelligence assessment. First Edition.

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Terminology	Likelihood	Return period (years)
Very common	greater than 1 in 10	10
Common	1 in 100 to 1 in 10	10-100
Uncommon	1 in 1000 to 1 in 100	100-1,000
Rare	1 in 10 000 to 1 in 1000	1,000 – 10,000
Very rare	less than 1 in 10 000	10,000 – PMF

Table 2: NICE probability of adverse reactions to drugs, translated to return periods

Comparing the translations of the IPCC and NICE guidelines into equivalent return periods, I think the NICE guidelines are closer aligned with the likelihoods being considered in flood hydrology. However, the terminology needs a category beyond Very rare to deal with truly exceptional floods such as those considered in reservoir safety or nuclear installations; my suggested taxonomy is listed in Table 3. I am unsure if the probable maximum flood (PMF) should have a category of its own (e.g. extraordinarily rare) which would remove the notion of an absolute upper bound on flood magnitude as implied by the 'maximum' term.

Terminology	Return period (years)
Very common	1.01-2
Common	2-10
Uncommon	10-100
Rare	100-1,000
Very Rare	1,000 – 10,000
Exceptionally rare	10,000 – PMF
Extraordinarily rare	PMF

Table 3: Proposed taxonomy for hydrological return periods

The proposed taxonomy would mean a drainage system should cope with an uncommon event (T=25 years), flood defences are designed to withstand a rare event (T = 100 years) and a class B reservoir should safely accommodate an exceptionally rare event (T = 10,000 years).

In Figure 2 the different ranges of return periods are highlighted on a traditional flood frequency plot combined with 110 AMAX events from gauging station 54002, River Avon at Evesham. The empirical return period for each event is calculated using the Gringorton plotting position .

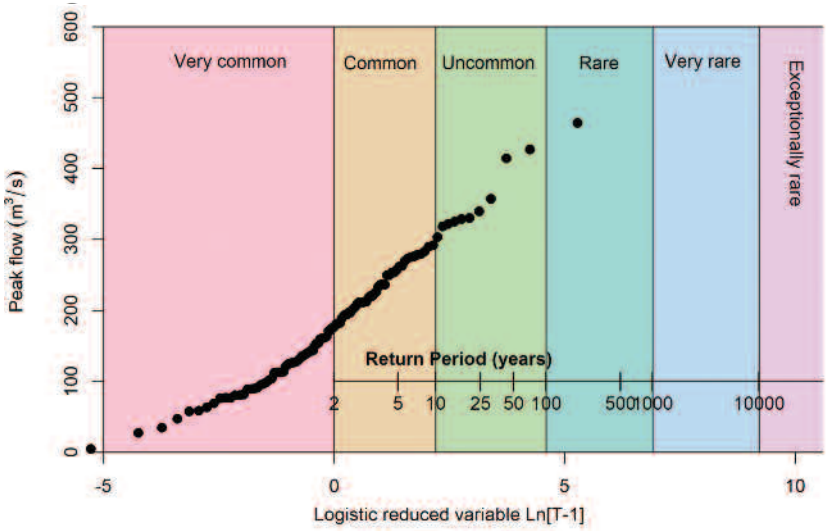


Figure 2: River Avon at Evesham, AMAX events banded according to the proposed classification

In Figure 3, 49% of the events are Very common, 40% Common, 9% Uncommon, 1% Rare, 0% Very rare or Extremely rare. When using Gringorton plotting position, a record length of 56 events or more is required in order to include a "rare" event. It seems reasonable that such a long record is required before any event can truly be labelled rare.

Hydrologists understand that risk, probability and uncertainty are an essential part of our work, and we are comfortable communicating with like-minded professionals. Communicating flood risk to a public audience is more difficult. With climate change making old concepts such as return periods redundant, and a wider environment where information is viewed with increasing scrutiny and scepticism, it might be time for hydrology to consider how we quantify and communicate flood risk, and if we are somewhat over-confident in the precision of our own probability calculations, to our own detriment.

British Hydrological Society

Annual General Meeting

The Society's AGM will be held during our symposium:
11-12pm, Tuesday 24th September,
Mathematical Institute, Andrew Wiles Building,
University of Oxford, OX2 6GG

Please join the meeting in person if you are able to. You can also join remotely, either by Teams conference call, or dialling in by phone.

To join by telephone: dial +44 20 3855 5143, and when prompted enter the conference **ID 913 598 389#**

To join the Teams call: use the link provided by email, then the meeting **ID 364 010 245 01** and passcode **8EMjat**
Or, scan the QR code:

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Circulation archive:

Thanks to the generosity of one of our members, a complete set* of Circulation going all the way back to Issue 001 in 1983 will soon be available in the ICE library in London. Check with the ICE Librarian before travelling, to make sure the archive is accessible (tel. 020 7665 2244).

**Except issues 49 and 53 – could anyone donate these?*

Should old water be taken with a pinch of salt?

Ian G Littlewood

An important difference of opinion exists in scientific hydrology concerning the variable proportion of 'old' water under an event hydrograph, where 'old' refers to water that was in the catchment before the start of the causative (new) rainfall. Eqs. 1 and 2 have been presented in the literature as the flow and tracer mass balances respectively at any time *t*: the superscript bracketed *S, O* and *N* denote stream, old and new respectively; *Q* denotes flow rate; and *C* is tracer concentration. Combination of Eqs. 1 and 2 leads to hydrograph separation by Eq. 3.

$$Q_t^{(S)} = Q_t^{(O)} + Q_t^{(N)} \qquad \text{Eq. 1}$$

$$Q_t^{(S)} C_t^{(S)} = Q_t^{(O)} C_t^{(O)} + Q_t^{(N)} C_t^{(N)} \qquad \text{Eq. 2}$$

$$Q_t^{(O)}/Q_t^{(S)} = (C_t^{(S)} - C_t^{(N)})/(C_t^{(O)} - C_t^{(N)}) \qquad \text{Eq. 3}$$

Based largely on Eq. 3, published papers have claimed high old water proportions during events, e.g. 0.9 *at peak streamflow* for a small headwater catchment in Wales. Similar results have been presented for catchments in other countries. Taking such results at face value, some research hydrologists conclude that the dominant storm streamflow generation mechanism is, therefore, one of displacement of old water by new rainwater. However, as will be discussed, Eq. 3 is basically unsuitable for hydrograph separation. Many published claims for very high proportions of old water at near peak streamflow (and associated suggestions that a displacement mechanism is dominant) should, therefore, be taken with a large pinch of salt.

Eqs. 1 and 2 (with slight changes to definitions as follows) have long been applied with a high degree of confidence for the carefully controlled steady-state mixing required for

streamflow measurement by the constant rate injection dilution gauging (CRIDG) method. For CRIDG the new water (*N*) is a strong tracer solution injected at a constant rate at the top of a stream mixing zone ($Q^{(N)} << Q^{(O)}$ and $(C^{(N)} >> C^{(O)})$. Examples of tracers are common salt and natural isotopes. The old water (*O*) is the stream water immediately above the injection point. Assuming $Q_t^{(O)}$ is constant, $C_t^{(S)}$ at the bottom of the mixing zone reaches a plateau. It is *only* at this plateau that Eqs. 1 and 2 apply. For CRIDG, Eqs. 1 and 2 are combined to give $Q^{(S)}$. Eq. 3 still holds but it has no utility in the context of CRIDG as it always returns a value of nearly 1.

Confidence in Eqs. 1 and 2 for CRIDG is far greater than using the same equations for hydrograph separation. The CRIDG system is, therefore, a useful benchmark. A natural catchment system is not even approximately like the CRIDG system, e.g. natural catchments are never steady-state and there is no single mixing zone with clearly identifiable constant flow and concentration inputs. Clearly then, Eq. 3 is not suitable for hydrograph separation. Published claims based on Eq. 3 for very high old water proportions of event stream water, *especially at and near hydrograph peaks*, should be treated with caution. It follows that arguments based on Eq. 3 for a dominant displacement streamflow generation mechanism during events are very weak (for small upland catchments in Wales at least). The case for dominance of old water at and near hydrograph peaks is further weakened by inspecting concurrent, high-frequency, hydrometric and water quality (conductivity) data.

Figure 1, presented and discussed at the 1991 BHS Symposium, shows 15-minute interval stage and stream water conductivity for two similar catchments in January 1986. Both are above Llyn Brianne, Wales and about 0.5 km apart; Nant y Gelli is 0.8km^2, and Nant y Gronwen 0.7km^2.

Consider the conductivity responses corresponding to

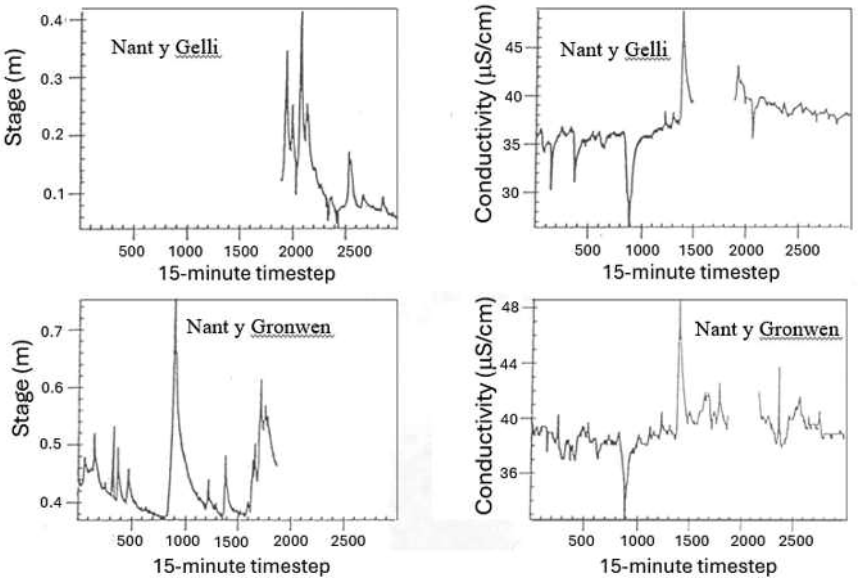


Figure 1: January 1986 15-minute data for two Welsh catchments

streamflow events at timesteps of about 900 and 1400. For both catchments at about timestep 900, conductivity decreases sharply at peak flow, i.e. dilution of relatively high conductivity stream water by low conductivity rainwater (this type of response was recorded at timestep 900 for other small catchments in the area). However, at timestep 1400 (14th January) conductivity increases sharply in both streams at peak streamflow. This enrichment response was recorded for several other catchments in the area at the same time and was caused by high sea-salt bulk deposition on the 14th, as indicated by measurements about 25km north of the catchments. Unless the dominant storm streamflow generation process was quite different for these two events (difficult to believe), stream water at and near timesteps 900 and 1400 comprised largely new rainwater which moved quickly to the catchment outlets, not displaced old water. How else can these 'V' and peak conductivity responses be explained?

European Geosciences Union conference, 2024

Alex Seawell

In April 2024 I received financial help from BHS to attend the EGU conference in Vienna, Austria. I would like to thank BHS very much for this assistance; it was an incredible experience which I was very glad to have the opportunity to attend. The EGU conference is huge, featuring approximately 20,000 presentations, so these are just a few highlights from those I saw! All presentations can be found at https://www.egu24.eu/home.html.

Some interesting historical research covered an extreme flood analysis of the Garonne River (France, *Michel Lang et al*) - floods dating back to 1435 were reconstructed using old maps and construction designs, to estimate riverbed elevation and morphological changes. Another project analysed flood types across Europe and found that dominant type changes with return period: in central Europe heavy rainfall tends to be more critical at high return period, whilst in northern Europe it is snowmelt (*Svenja Fischer et al*). On the subject of weather prediction, NOAA is engaged in two complementary projects at different ends of the modelling spectrum: one transitioning their many separate models into a 6-way coupled earth modelling system, the second using machine learning to provide rapid predictions (*Vijay Tallapragada et al, Aaron Hill et al*).

In the UK research is looking to improve forecast lead times, currently hampered by the lack of instrumentation in the surrounding ocean, by using satellite as well as ground gauging data (*Cristiane Girotto et al*). A study of beaver dams in south-west England suggested they caused a buffering effect on downstream water quality (*Gareth Bradbury et al*).

Citizen science has become a big area; several projects had citizens record hydrological information to inform water quality mapping, DEM flow route improvement and AI algorithm development *(Armin Moghimi et al, Ho Tin Hung et al, Peter Fischer-Stabel et al*), and fit weather gauges to bikes, buses and boats (*Nicola Loglisci et al*).

My own presentation was a poster (*Alex Seawell et al*) - I wasn't left standing self-consciously for long, and received some helpful comments for the future. Other interesting posters included weighting ensemble forecasts based on model skill in predicting hydrological parameters (*Mehrad Rahimpour Asenjan et al*); the development of kerb and manhole flow gauges to record urban flooding such as the Seoul August 2022 flood (*Ki-Won Lee et al*); an underground SWMM model created to simulate urban flooding during the 2001 event in Taiwan which had badly affected subway stations and rail tracks (*Yong-Jun Lin et al*); a groundwater monitoring network in Rome, developed by repurposing its 200 existing (mainly irrigation) water wells (*Francesco La Vigna et al*). One which I know caught several people's eyes used a beautifully knitted format to impress its point about knitting global and local model information! (*Katie Facer-Childs et al*).

EGU features more than just project presentations, for example I attended a panel discussion on "The Great EGU Climate Debate: The Anthropocene – Apocalypse Now" which covered issues of leadership, misinformation and finding your own role in combating climate change, and another on "Building meeting grounds between the Global South and North: how do we move away from neo-colonial geoscience research structure?", where the panelists described their experiences of helicopter science and, along with the audience, discussed recommendations for better practice in the future.

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On the influence of rain shadow (exposure) on QMED

Paul Webster—Corylus Planning & Environmental Ltd

The "rain shadow" principle is familiar to any student of UK physical geography, so profound is its effect in the UK. However, its impact on flood frequency is less clear. I was recently alerted to it when undertaking a typical flood analysis for an ungauged catchment in mid Wales. I noted that *all* candidate donors for QMED showed that the standard equation over stated QMED. Shortly after, when undertaking a flood frequency analysis for the River Wye, I noted that the equation again overstated QMED by the rather large margin of 50%, and found a similar result for the River Coln at Bibury. These findings prompted the cursory investigations that are described here.

The straightforward analysis involved selecting catchments from the NRFA database, and extracting catchment descriptors for each to allow the calculation of $QMED_{CDS}$. This was compared with the value of $QMED_{OBS}$ given in the database.

The results are shown in Figure 1 (full data available on request), with a map of the ratios in Figure 2. These lead to the following observations:

- There is a large range in ratios, from around 0.7 (Tyne at Bywell and Almond at Craigiehall) to 1.5 (Wye at Belmont and Coln at Bibury). The highest ratio is 2.02 for the Cherwell at Enslow;
- There is reasonable consistency (with high ratios) for catchments from Mid Wales, through the Midlands, East Anglia and southern England, with the occasional exception such as the Teme at Tenbury (0.87);
- The majority of other catchments have ratios of 1 or less

though the pattern of ratios for Scotland is less clear, due in part to the small number of catchments analysed.

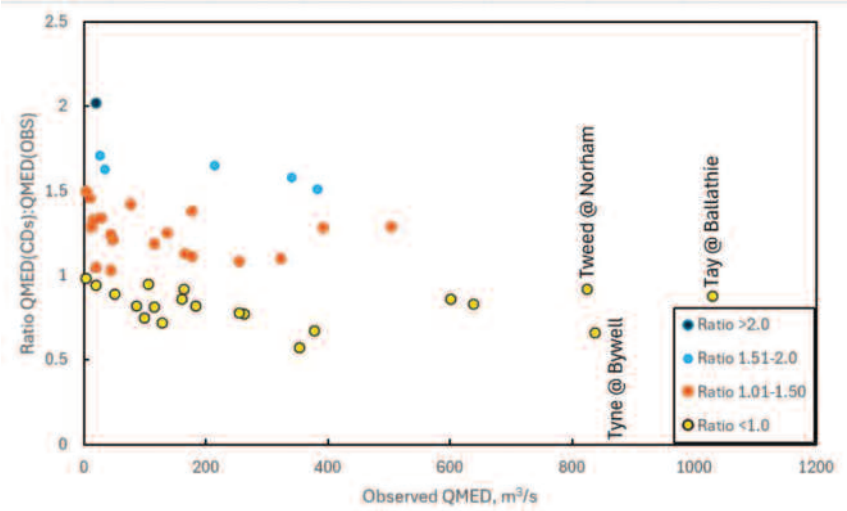


Figure 1: QMED ratio vs. observed QMED for 47 UK catchments

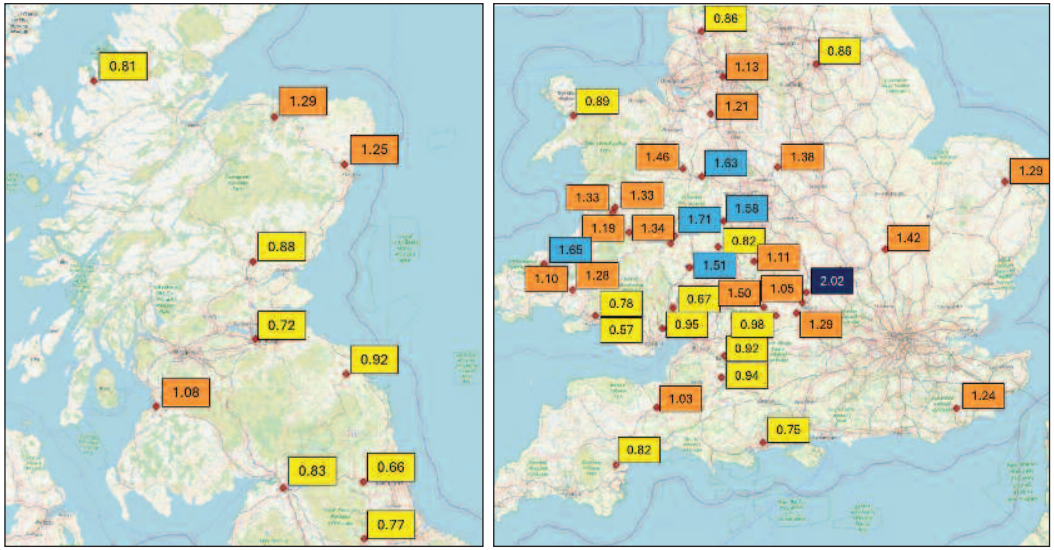


Figure 2: Maps of QMED ratios for 47 UK catchments

The most striking outcomes were the wide range and the spatial consistency of the ratios, which seemed to support my hypothesis about rain shadow effects.

FEH procedures make formal provision for adjusting $QMED_{CDS}$ using nearby catchments, which recognises the spatial correlation of QMED residuals and provides a practical way to adjust QMED. However, adjustments can only be made where there are suitable donors, and may be confounded near any spatial discontinuity in residuals.

These cursory results somewhat support a rain shadow effect on QMED. Since SAAR (Standardised Annual Average Rainfall) is an independent variable in the QMED equation, rain shadow is implicit in the equation. However it may be more appropriate to view this tendency as one of exposure, to cover a continuum from profound rain shadow through to a high degree of exposure to rain (storm) bearing winds.

Parameterising a rain shadow effect on a catchment is fraught with difficulty. A topographic index might reflect exposure, but the effect is likely to vary with the prevailing direction of storm bearing winds, which will vary within large catchments. Given this complexity, a rainfall-based approach may be warranted, perhaps by referencing residuals from a local/regional precipitation-elevation model, or by reference to seasonality of extremes.

Development of a UK index-flood equation is fiendishly difficult, given the range in catchment types and flood-producing weather systems, but catchment exposure may give improvements as an independent variable.

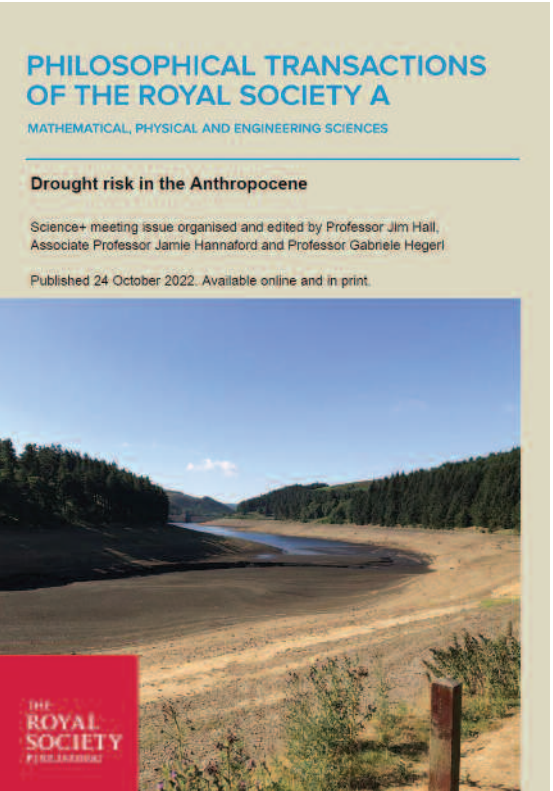
Expanding this analysis to the full NRFA data set would help to confirm if there is any systematic UK variation, and whether the inclusion of exposure (or lack of it) as an independent variable in the QMED equation is warranted.

Forthcoming BHS events

BHS National Symposium

The 2024 British Hydrological Society National Symposium will be hosted at the University of Oxford from 23-24 September 2024.

This event will showcase research across the hydrological community, and include workshops, discussions, a field visit and conference dinner. To book your place, go to https://tinyurl.com/3s7t7ev5



In October 2022 The Royal Society published Drought Risk in the Anthropocene, organised and edited by Prof Jim Hall, Associate Prof Jamie Hannaford and Prof Gabriele Hegerl.

This is now one of their most highly cited and widely read issues. The articles can be accessed directly at www.bit.ly/TransA-2238, or you can buy a print copy at the reduced price of £40 by contacting sales@royalsociety.org.

Update from the UNESCO Intergovernmental Hydrological Programme

Jo Savage and Harry Dixon, UKCEH

The UNESCO Intergovernmental Hydrology Programme (IHP) held its 26th Council Session at UNESCO Headquarters, Paris, from 3-7 June 2024. Since its inception in 1975, the IHP has worked to strengthen networks between UNESCO's 194 Member States to advance freshwater research, management, education, and capacity development. The Council assembles every two years to review the IHP's progress and make decisions on its future direction. The UK has a long history of active engagement in both the strategic governance and delivery of the IHP, including leadership in some of its major programmes and flagship initiatives (FIs), such as FRIEND-Water (Flow Regimes from International Experimental and Network Data) and the ISI (International Sediment Initiative).

The week began with a Scientific Colloquium, where 12 keynote speakers and 15 panellists showcased the scientific achievements of IHP. The event highlighted how the programme has responded to urgent water-related needs of societies by operationalising scientific knowledge, tools, and methodologies, including flood and drought monitoring, groundwater assessment, water quality monitoring, glacier modelling, and ecohydrology approaches. Participants discussed emerging hydrological challenges in the context of rapid global change and unprecedented technological advances. They also shared their perspectives on opportunities for the IHP to help address these challenges.

On day two, a symposium demonstrated how UNESCO's Water Family (a network of 84 Water-related Chairs/ UNITWINs, 170 IHP National Committees/focal points, 29 Water Centres and 16 FIs) are instrumental to improving knowledge and building capacity for sustainable water management at all levels. One such Centre is the UNESCO Category 2 Centre for Water Law, Policy, and Science (CWLPS) at the University of Dundee. CWLPS delivers much needed global education and research in sustainable water governance. Additionally, the University of Birmingham holds a UNESCO Chair in Water Science and leads a UNITWIN network. Through the Chair/UNITWN Programme, the university collaborates with higher education communities internationally to develop pioneering approaches to solve the water crisis.

The final three days were reserved for the Council to review activities currently being implemented under the ninth phase of the IHP: *IHP IX - Science for a Water Secure World in a Changing Environment (2022-2029)*. The UK currently sits on the Council, along with 35 other elected Member States. Harry Dixon (UKCEH) led the UK delegation, bringing international water experts from the Universities of Birmingham, Coventry, and Dundee and coordinating their collective input. IHP-IX is centred around five key interrelated priority areas, geared towards accelerating the implementation of the Sustainable Development Goals:

1. Scientific research and innovation;
2. Water education in the Fourth Industrial Revolution including sustainability;
3. Bridging the data-knowledge gap;
4. Integrated water resources management under conditions of global change;
5. Water governance based on science for mitigation, adaptation, and resilience.

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There have been considerable improvements in the monitoring of FIs activities and their alignment to IHP phases. CWLPS received approval to continue its efforts rejuvenating HELP (Hydrology for the Environment, Life and Policy). FRIEND-Water, ISI, and G-WADI (Global Network on Water and Development Information in Arid Lands) were among the FIs commended on their progress, which all receive notable contributions and steers from UK scientists.

Looking forward, the Council discussed key events taking place in 2025 - a significant year for UNESCO, marking the 50th anniversary of the IHP and 60 years of water sciences at UNESCO since the International Hydrological Decade. The Council approved plans for a global event in Paris on 11 June 2025 to celebrate this milestone. Outcomes produced from the Scientific Colloquium and Water Family Symposium will be dedicated to the anniversary. In alignment, the UK National Committee will hold a national conference with the BHS in the second half of 2025, reflecting on the impact of UK involvement with the IHP, and how best to support and benefit from UN hydrology going forwards. In 2025, the IHP will also join with the WMO to support the 'International Year of Glaciers' Preservation', emphasizing the importance of adaptation and mitigation actions in preserving glaciers. The Secretariat for the UK National Committee for the IHP, operated by UKCEH, is keen to hear from anyone who feels their activities may contribute to IHP-IX, so that a coordinated input from UK hydrology may be put forward. Suggestions regarding 2025 events are also welcomed. To contribute ideas or enquire further, please contact the Committee secretary Jo Savage: joan@ceh.ac.uk.

For further information about the IHP: https://www.unesco.org/en/ihp

2024 Peter Wolf Symposium

Giuseppe Degan Di Dieco

The 2024 Peter Wolf Symposium took place on the 8th and 9th of May at The Humanities Complex, University of Bristol (UoB). Sunny weather welcomed 50 attendees for a hydrology marathon where universities, consultancies and regulators across the country were represented. Special thanks go to the event sponsors Jacobs, the UoB Faculty of Engineering via Dr Miguel Rico-Ramirez, the UoB School of Geography via Dr Gemma Coxon, and CivilMind Engineering via Dr Ivan Del Mastro - without their help the event would not have been possible.
On the first day, BHS President Duncan Faulkner opened the symposium with an inspiring opening address on activism and connection. Then, Dr Sara Alexander (Environment Agency) delivered a keynote talk on rescuing data. Subsequently, presentations ranged from predictive hydrology to hydraulic modelling, followed by Liv Burns (Jacobs) who hosted a lively career panel with Duncan Faulkner, Dr Sara Alexander, Dr Gemma Coxon (UoB), and Adam Parkes (Jacobs); the panelists inspired early career hydrologists with their tales.



The poster session included topics on droughts, flood resilience, seasonal forecasting and satellite hydrology. The discussion was engaging alongside tasting cakes and sipping drinks. At the end of the day, attendees had a chance to recharge their mind and body with a world banquet dinner at Bristol Harbour, in a ship shape and Bristol fashion.
On the second day, the talks presented analysis and monitoring of hydrological data, followed by an eye-opening session where Dr Victoria Coates (Environment Agency) presented different visual problems and their impact in hydrology. Dr Sebastain Steinig (UoB) illustrated how to effectively project global climate data for public interaction. Attendees plotted maps to investigate how the weather would have been during the time dinosaurs existed.

As our flagship trip, attendees had a chance to mingle with the Bristol community by exploring Banksy's graffiti in the city centre and along the River Avon, recharging their batteries for the next speaker. Adam Parkes (Jacobs) gave a keynote talk about the history of hydrology in the UK and the digital transformation within the industry, as well as introducing the Jacobs' software 'Flood Modeller'.

We congratulate Molly Asher (University of Leeds) who won the prize for the best longer presentation, Rachael Armitage (UKCEH) who won the prize for the best quickfire presentation, Louisa Oldham (UoB), and Cerith Morgan (Newcastle University) who shared the podium for the best poster presentation. Congrats again to you, water drops!

Thanks to you all, sponsors, keynote speakers, and attendees, we hope the symposium momentum will last in each of you. Organising the symposium was a pleasure and an honour. Cheers to hydrology! Cheers to you! Cheers to the BHS!

The 2024 Peter Wolf Symposium was organized by Gemma Coxon, Giuseppe Degan Di Dieco, Liv Burns & Alannah Killeen.

New members of British Hydrological Society

Mabelle Loseby
Christopher Print
Elizabeth Moore
Harry Ormonde
Heather Scott
David Carruth
Christopher Masufu
James Buckley
Shubham Tiwari
Joseph Robinson
Haider Ali
Emma Fussell
Esme Callander
Samuel Bray
Samson Senbore
David Bryan
Elizabeth Lewis
Muhammad Ali
Wapatwa Silungwe
Isabelle Finlay
Mohaddeseh Mousavi Nezhad
Kanzis Mattu
Nicole Forstenhäusler
Farzaneh Aghajani
Judy Smith
Tasneem Khan
Laurence Cullen
Kevin Griffiths
Donald Edokpa
Donald Rwasoka
Hephzibah Neate
Shasha Han
Kit MacLeod
Chidinma Igwenagu
Rupreet Mead
Prateek Singh
Lucy Whitelock-Bell
Jennifer Pirie
Sikhanyisiwe Mandipe
Freek Van Arkel
Abdul-Azeez Umar-Babba
Abolghasem Akbari
Emelie Persson
Nikhil Rathy Ramachandran
Thomas Young
Scott Dawson
Michaela Connolly
Louise Dobinson
Burak Bulut
Mark Fermor
Neeraj Sah
Sarah Warren
Fiona Cuthill

Welcome all!

Circulation

UK Hydrological Bulletin, May-July 2024

Terry Marsh, UKCEH Fellow

At the national scale, rainfall for the May-July period was very close to the long-term average but the hydrological response was substantially influenced by rainfall over the preceding eight months - the UK having recorded its wettest September-April on record. With soils near to saturation, and notwithstanding a dry spell in early May, much of the country remained very vulnerable to further significant rainfall throughout the late spring and early summer. This was particularly true of rivers with baseflow-dominated regimes and was heavily underlined during late May when extensive and protracted flooding impacted on much of the country. Further moderate flooding occurred in mid-June contributing to England's highest January-June runoff in a series from 1961. River flows generally declined through the latter half of July but, with groundwater levels and reservoirs generally above average, the water resources outlook for the late summer and early autumn was healthy across most of the UK.

May 2024 was the UK's warmest on record (in the Met Office series from 1884) with cloud cover contributing to particularly elevated nighttime temperatures. Whilst the national rainfall total was close to average, regional and local



View of the River Greta catchment, Cumbria, from Blencathra (T. Boase)

contrasts were very substantial. Parts of Northern Ireland and north-west Scotland recorded less than 50% of the average whilst in parts of Dorset, East Anglia and southern Scotland rainfall totals exceeded 200%.

Over the first three weeks outflows from the UK generally followed the normal seasonal recession (Figure 1) but increased dramatically on the 22nd which was the wettest spring day on record for northern England – 95 mm being recorded at Keswick. Flood alerts were extensive and thunderstorms produced significant localised flooding and transport disruption.

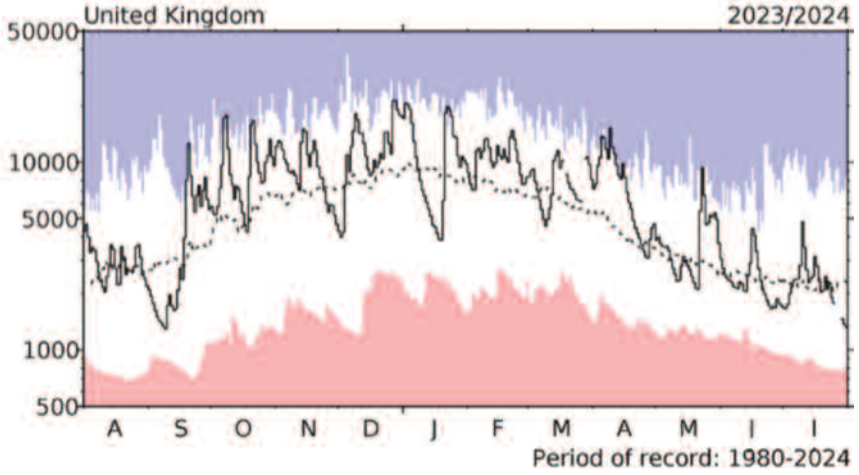


Figure 1: Daily outflows (m³/s) from the UK (solid trace). The blue and red envelopes are the daily extremes and the dotted trace is the long term average.

The Rivers Clyde and Tweed were amongst those registering an order of magnitude increase in flows over a couple of days, and flash flooding impacted many urban areas (e.g. Edinburgh).

Across southern England flows in most groundwater-fed rivers remained notably high – for the Itchen (Hampshire)

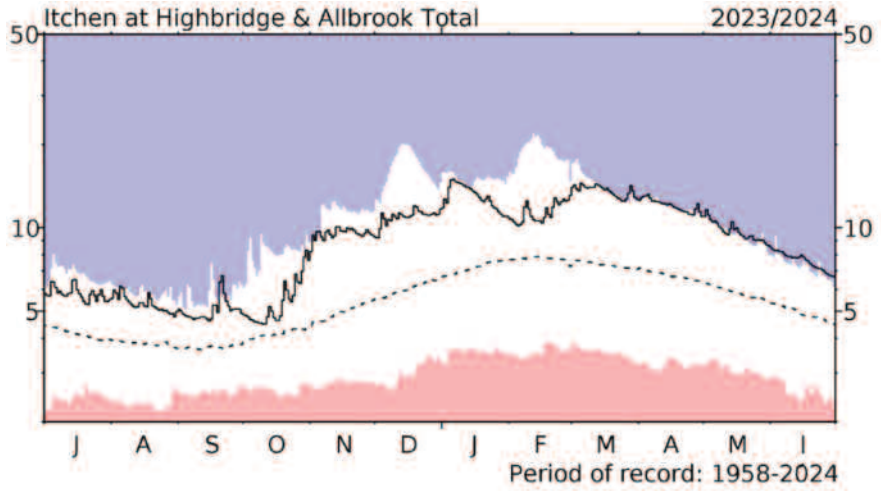


Figure 2: Itchen at Highbridge & Allbrook Total flow, m³/s. Blue, red: long term maxima and minma. Broken trace: long term average.

flows remained close to, or above, the highest flows on record for the time of year (Figure 2).

June saw something a of a reversal of the May rainfall pattern. For the country as a whole rainfall was around 20% below average but regional contrasts were again very substantial. Parts of northern Scotland recorded over 170% of average rainfall whilst much of southern Britain registered less than 35%. The preponderance of airflow from the north contributed to below average temperatures and moderated evaporative demands. This, together with contrasting catchment geology, made for exaggerated spatial contrasts in runoff patterns.

In northern Scotland, the Oykel registered more than twice its June average flow whilst the Tywi (Wales) and Taw (Devon) recorded less than 40%. Reflecting the exceptional aquifer recharge across much of the country over the winter and spring, groundwater levels at index boreholes were generally notably high. In the Upper Greensand of south-

west England, the Lime Kiln Way borehole recorded its highest June level in a 55-year series.

At the national scale, rainfall for July was very close to the long-term average but regional contrasts were again substantial – much of Scotland and Wales recording below average rainfall whilst parts of southern and eastern England were notably wet; this was true of the second week particularly. In North Yorkshire, the Loftus Samos raingauge recorded 58 mm on the 10th and a further 47mm on the 14th - triggering spates in many Pennine rivers.

Generally, the second half of the month was characterised by steep recessions and July runoff totals were only around half the long-term average for many western index rivers again including the Tywi and Taw; this was true of the River Bush in Northern Ireland also. By contrast, groundwater levels mostly remained notably high for the late summer – in northern England the boreholes at Skirwith (North Pennines) and Aycliffe (Durham) reported their highest July levels in series of 44 and 49 years respectively. Reservoir stocks in England & Wales generally declined modestly over the month but remained appreciably above the late-summer average at month-end (Figure 3).

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.

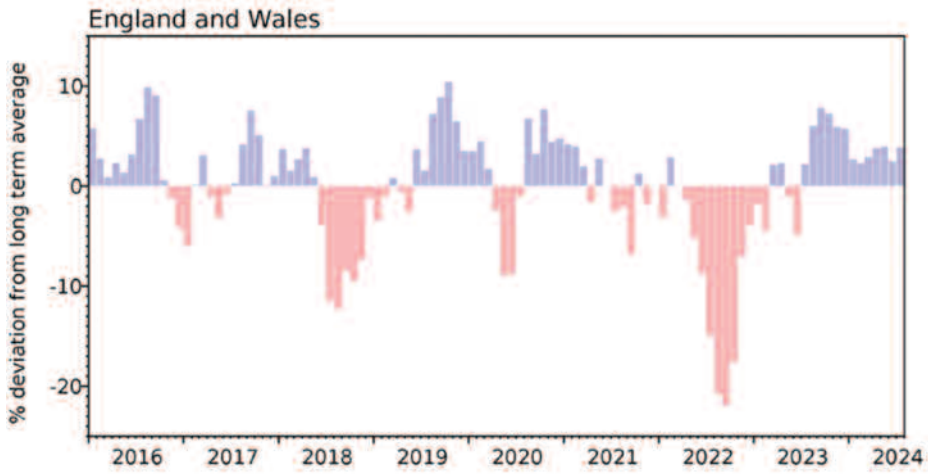


Figure 3: A guide to the overall reservoir stocks for England and Wales.



Tidal Loch Carron, Scottish Highlands (V. Shackle)



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