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The newsletter of the British Hydrological Society

40th anniversary special edition



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Cover photo: River Wear at Frosterley (Vicky Shackle)

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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.

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. Hydrological photographs particularly welcome.

British Hydrological Society

1983-2023

Welcome to the

40th anniversary issue of Circulation

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New BHS members

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UK Hydrological Bulletin, November 2023-January 2024

Could you spare any time?

There are vacancies on several BHS sub-committees - if you could spare time to contribute, please contact Duncan at bhs-president@outlook.com, or see the contact details on page 7.

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Introduction to the 40th anniversary edition



2023 marked 40 years since BHS was formed—the inaugural meeting was held on 1st November 1983 at the Royal Society. On 6th November 2023, over 130 members attended our 40th anniversary event at the Institute of Civil Engineers, to hear presentations from across the hydrological spectrum.

Six of those presentations are reproduced here in this special (extended!) edition of Circulation, together with an account of the NRFA anniversary webinar and a conference report — many thanks to everyone who has written an article. Above, our President is cutting the BHS 40th birthday cake, at the reception held after the anniversary event. Happy 40th birthday, BHS!

In this edition we also have a double-bill of the Hydrological Bulletin, so we are back in step with the seasons. As always, I'm really keen to receive written and pictorial contributions for our magazine from members who represent all sectors of BHS, especially early-career hydrologists.

Vicky Shackle (Editor)

President's perspective Duncan Faulkner

Over the last few months, floods have kept many members busy. Huge thanks to all who have run forecasts, issued warnings, checked defences or gauged flood flows. Let's hope for a quieter spring during which we can take stock.

Meanwhile, concerns over water resources and pollution haven't gone away. BHS is represented on CIWEM's Water Resources Panel, which met in January to launch an independent review of water sector performance and governance: A Fresh Water Future. It calls for an urgent, refreshed approach to managing water quantity and quality in the UK.

The expertise of hydrologists is needed more than ever, so it's encouraging to hear NERC are funding four new centres for doctoral training, three with a watery theme: flooding (led by the University of Southampton), freshwater early warning systems (University of Bath) and wetland wildscapes (Herriot Watt University). Let's hope for lots of new members!

The Main Committee recently voted to offer free membership to undergraduates, and to extend the discounted £15/year membership offer to all early career researchers or practitioners up to five years after first graduation. Please spread the word and encourage your colleagues or students to sign up. Early career members are welcome at all BHS events and also have an opportunity to get together in a supportive atmosphere during regular webinars and the Peter Wolf Symposium, which this year will be at Bristol University on 8-9 May. I'm looking forward to seeing many

members this year, in particular at our Royal Society conference on 10-11 June (London) and our symposium on 23 -25 September (Oxford).

Finally, a thought on "thingification". As a science, hydrology inevitably reaches for numbers and concepts as a way of understanding the water environment. This gives us the ability to quantify, predict and manage. But do we lose something else? I've been fascinated by the Riverkin project by water@leeds (Cohen et al., 2023), exploring how kinship with rivers is central not just to Indigenous understanding, but could put our relationship with water on a more sustainable footing; people will fight more passionately for their kin than for a thing. Of course many hydrologists experience water as so much more than a set of numbers: a source of life, beauty, solace and healing. But there's also a deep spiritual attraction and connection to water forming a silver thread running through the depths of time, linking Indigenous cultures and Pagans with Celtic or Franciscan Christians, on through the centuries to today's devotees of wild swimming or surfing (see Easkey Britton's writing).

Speaking of which, I need to cycle off to the canal lock now to take the Sunday morning weather reading - encapsulating the wonder and beauty of 24 hours of weather in numbers.

References: **Cohen, J. B. et al.** (2023). Riverkin: Seizing the moment to remake vital relations in the United Kingdom and beyond. People and Nature, 5, 1877-1892. https://doi.org/10.1002/pan3.10534. **Easkey Britton** (2023). Ebb and Flow: How to Connect with the Patterns and Power of Water. Watkins Publishing.

Celebrating 40 years of the UK National River Flow Archive

Isabella Tindall & Paul Sadler

At a joint British Hydrological Society, UK Centre for Ecology & Hydrology and Environment Agency webinar on Thursday 12 October 2023, the history of the National River Flow Archive (NRFA), and uses of its data, were presented. An online video is available at https://youtu.be/VjbE-4Pn4kA, and some time stamps are quoted below. Over 100 people attended and the talks were very well received.

For the last 40 years, the NRFA has underpinned hydrological research and water-management activities, and delivered data and expertise to UK Government and international organisations. The NRFA acts as the main focal point for hydrometric data in the UK, providing stewardship of, and access to, daily, monthly and flood peak river flow data from over 1,500 gauging stations across the UK.

Jamie Hannaford (03:30 to 25:00) presented an overview of the Archive putting it into the context of the Surface and Groundwater Archives Committee (SAGA), who oversee the activities of both the NRFA and the National Groundwater Level Archive. Jamie explained how the Archive has developed over the last 40 years, and looked ahead to the future of AI and machine learning technologies.

Katie Muchan and **Penny Hearn** (27:00 to 43:20) provided Measuring Authority perspectives on using the NRFA, and the importance of hydrometric data. They celebrated 40 years of collaboration, highlighted some of the benefits, provided

case studies, and looked forward to the next 40 years.

Saskia Salwey (44:57 to 55:40) focused on incorporating reservoir representation into national-scale hydrological modelling across Great Britain. She uses the NRFA data downstream of reservoirs to validate and calibrate models to try and understand how the reservoirs are operated and what impact they are having on the flow regime.

Anthony Hammond (JBA Consulting) (58:44 to 01:08:43) highlighted the foundational role that data and statistical methods have for civilization, and the importance of freely available data for the progression of science. He gave examples of using NRFA data for flood risk management.

Louise Slater (01:09:46 to 1:20:29) presented research projects developed using NRFA data. These included estimations of historical changes in the occurrence of severe river flooding, and future flood predictions for Great Britain.

The benefit of the archives and the importance of their continued stewardship were clear. **Robert Grew** observed that the frequently cited African proverb (also often attributed to others) seemed very apt:

'*If you want to travel quickly, travel alone but if you want to travel far, then travel together*.'

As many communities interested in the archives have aims and objectives that require high quality, long-term data sets, it's going to be important to continue the journey together.

NRFA Data Search page: https://nrfa.ceh.ac.uk/data/search.

Black swans in hydrology

Dave Archer—JBA Trust and Newcastle University

What have Black Swans to do with hydrology? This is a concept to describe observations or events which are outside the realm of previous experience. Before the settlement of Australia, people in Europe were convinced all swans were white. The observation of Australian black swans illustrates the limitation to our learning from observation. A single observation can invalidate a general statement derived from millennia of observations. During my 50 odd year career in hydrology, I have encountered three 'black swans in hydrology' which I presented at the 40th Anniversary conference. Here is one of them, about rates of snowmelt.

As part of the research for the Flood Studies Report (NERC, 1975), two strands of research on snowmelt were carried out; on maximum rates of snowmelt runoff by Newcastle University and on extreme point rates of melt by the Met Office.



Flooding at Olivers Mill Morpeth, March 1963 (Archive of D.Archer)

Rates of maximum snowmelt runoff

The focus was on snowmelt floods in northeast England where the greatest floods of the 19th century on the Tyne were snowmelt floods without rainfall in 1815 and 1881. However, the key numerical evidence was the extreme snowmelt flood of March 1963 on the river Wansbeck in northeast England. This was the greatest flood in 100 years, flooding 600 properties in Morpeth. In an event with less than 5 mm rainfall the peak rate of runoff was 4.26 mm/h (peak flow = 340 m^3/s: Catchment area = 287.3 km^2). Further events with similar rates of peak runoff were identified by observations on upland Pennine catchments in the snowy winters of 1978 and 1989.

Rates of maximum point snowmelt

Maximum rates of point snowmelt showed a puzzling contrast with the runoff estimates. They were derived by measurements of the decline in water equivalent of snow at meteorological stations in Britain. It was concluded that 42 mm/day (1.75 mm/hour) was a realistic design maximum for probable maximum flood estimation in combination with maximum winter rainfall. Similar point melt rates were typically observed in Scandinavia and the United States.

The melt runoff rate for northeast England catchments was set aside and the Met Office value was adopted by ICE (1978) (Floods and Reservoir Safety) for spillway design and appraisal for Probable Maximum winter Floods. Subsequent theoretical studies suggest that energy input under certain

conditions could cause a point melt rate much higher than 1.75 mm/h (42 mm/day). A Met Office study in 1998 noted that melt in saturated air at 10 °C, with U = 20 knots gives 117.5 mm/day (4.9 mm/h), though such a point melt would result in a much lower rate of melt runoff.

Melt runoff rates seem higher than can reasonably be assigned to the energy exchange. What factors other than very unusual weather conditions could enhance the runoff from snowmelt to cause flooding related to snowmelt?

I conclude that storage of liquid water in the snowpack and its eventual release (along with the current melt) in what has been described as the collapse of the pack, may give a much higher release at the base of the pack contributing to runoff than the rate of melt at the surface. Available storage is usually specified as a proportion or percentage of the snowpack water equivalent. Studies in Alpine catchments suggest that liquid water volume in the snowpack could reach more than 25%. Release of this proportion of liquid water along with coincident melt could significantly increase the contribution to flood runoff.

Other factors include frozen ground enhancing the percentage runoff, suggested as a contributor to the great floods of 1947 and the fact that snowmelt can be simultaneous over most of the catchment, in contrast to summer, mainly convective, rainfall which may be very localised.

Conclusion

These snowmelt runoff observations may be considered **black swans** as they have the potential to make a reassessment of global response to risks of snowmelt floods. If hydrologists make observations of events which don't correspond with theory or don't fit the current model don't blame the data – but check them. The 'black swan' you have encountered may be the most important discovery in your career.

River Wansbeck Telford Bridge, Morpeth, March 1963 (Archive of D.Archer)



What does it mean to be a UK hydrologist in 2023? Where next for flood hydrology expertise?

Anita Assadullah—Environment Agency

Last year, BHS surveyed people working in hydrology, asking them who they are, what they do and why*. The information provides a snapshot of the hydrological community in 2023, and a baseline against which to monitor change. So how might things change in flood hydrology? I, for one, worry about the loss of expertise we are facing as previous generations retire.

Operational UK flood hydrologists of my generation (40 years old) will have largely used FEH methods and software. These have provided a consistent, evidenced approach and guidance to practitioners, but the efficiencies created by the software may also have had some unintended consequences (the developers of FEH were also concerned about this). One could argue that FEH software has given users of flood analyses the wrong impression that a) hydrology is an exact science—hands up all those who, as graduates, reported a 1% AEP peak flood flow to 3dp; b) hydrology cannot be questioned - the black box nature of the software does not allow for common-sense testing; and c) hydrological analysis is quick and straightforward if someone has software training – consultants are sometimes given just a few hours for hydrological analysis.

So, part of FEH's legacy might be that decision-makers do not engage much with hydrology and perhaps therefore do not

value it; people do not understand that some results are more robust than others (even within a consistent approach) so struggle to make appropriate allowances for uncertainty; and importantly, that hydrological expertise is not greatly valued, which means practitioners are not afforded the time to develop the same depth of hydrological understanding that previous generations were.

So where do we go from here in operational flood hydrology?

We have the UK Flood Hydrology Roadmap, developed through consultation. Described by Rob Lamb as, "a once-in-a-generation opportunity to work together as a diverse coalition", it sets out a vision and activities to progress towards it.

I would argue that to safeguard the future of hydrological expertise it is important that along that journey we also learn from the past and consider the following:

- We must ensure future methods empower those who commission hydrology to visualise, understand and question our methods, that they may value what they can see and interact with.
- We must communicate clearly that not all data points are equal. Perhaps a colour-coded index could allow people to quickly understand how 'real' datasets are. A proxy for some uncertainty perhaps, indicating how much quality measured evidence is contained within the number, how concentrated it is (thus highlighting

the importance of observations at the same time).

- We must allow users to easily discriminate between a high quality analysis and a poor one. Perhaps we can create a quality standard- a hydrological 'kitemark', which may support the use of expertise.

We cannot underestimate the scale of the challenge. In a world where we are constantly asked to do more in less time, is it realistic that will be given the time and space to be as thorough as our predecessors? To investigate raw data and reach an understanding of the problem first rather than just producing results quickly? How much does that really matter? Will the uncertainties not always be large anyway? Some may argue we instead just need more freeboard or operational preparedness. I believe that hydrological expertise is more necessary than ever to make intelligent interventions, but we perhaps have to accept that some hydrological knowledge will be lost as people retire, and may not be replaced. We will instead move forward in a new direction developing new types of expertise, less 'grounded' perhaps but using more information from more places. What is clear is that whatever we do, we have to both demonstrate our worth and help others use our work appropriately.

(**The results of the BHS survey are available on the EA Flood Hydrology Improvements Programme website* (https://engageenvironmentagency.uk.engagementhq.com/w4-skills-survey), *for people to interpret)*

The women of hydrology

Imogen Barnes—JBA Consulting

For thousands of years, the collection, monitoring and management of household water resources has been considered "women's work". As a result, women have a unique perspective and relationship to water relative to their male counterparts. In Western societies, technology and infrastructure separate us from the everyday need to collect water. Thus, we see water as a resource which requires management, exploitation, and scientific exploration. Traditional knowledge systems are far more likely to think of water as a spiritual entity with a reciprocal relationship - we look after it, and it looks after us. It is generally the women of indigenous societies who are the primary holders of this life-giving information. Sadly, "women's work" has often been undervalued and poorly documented in literature.



Artwork by Amanda Phingbodhipakkiya

The intention of my research project presented at the 40th Anniversary BHS conference was to pay tribute to the scientific contributions of the women who have gone before me, and to highlight the wealth and value of traditional water knowledge systems.

Throughout history, there are very few examples of women's scientific contributions to hydrology. Exceptions include the powerful Babylonian Queen Sammu-Rammat who, according to the Greek historian Herodutos, built large embankments on the River Euphrates to protect the city of Babylon from seasonal floods; the surprising, but intriguing, evidence of the early adoption of lead piping and conduits (1135 AD) for water supply and drainage found in female religious housing in Europe, made possible by their status as educated individuals with wealthy benefactors. The purposeful exclusion of women from hydrology (and all science) persisted, with most academic societies not permitting women until the mid-20th century. As a result, many key discoveries were overlooked (the Greenhouse Gas effect was attributed to John Tyndall in 1859, but Eunice Foote published her paper on the topic three years earlier and was largely ignored). Incredible female pioneers throughout the 20th century have paved the way for the industry which we know today. I, early in my career, have not suffered academic disparagement as a result of my gender thanks to them. Some honourable mentions (all worth a Google) are Nora Dowell Stearns, Pelageya Yakovlevna Polubarinova-Kochina, Prof. Malin Franklenmark,

Dr. Letitia Obeng, Dr. Xueyu Lin (林学钰), and Dr. Sulochana Gadgil.

In many indigenous communities, water knowledge is highly gendered, sometimes due to gender roles surrounding the division of domestic labour, but also because of the spiritual attributes given to water and to women. In the Ojibwe tribe of Canada "women are life givers, and so is water", and so they are the keepers of the water knowledge via oral traditions. Many established 'scientific' hydrological principles are conveyed through these stories when interpreted correctly (e.g., the water cycle and geomorphological principals; Todd et al., 2023). Encouragingly, efforts to document the wealth of indigenous women's knowledge of water sources, flow pathways and seasonal changes through mapping projects have been highly successful (e.g., projects with the Samburu tribe in Kenya and with the women of the Badia region of Jordan). Beliefs which hold water as a spiritual entity lead to hydrological and environmental practices which focus on sustainability and community access for all. The loss of indigenous knowledge and these attitudes are costly and have been directly attributed to major losses in wetland area and biodiversity in the Teso areas of Uganda and an increase in unequal access to clean water in Nkayi, Zimbabwe. By highlighting the knowledge systems of indigenous peoples, and women especially, I hope to provide food for thought in expanding our definition of what counts as hydrology and therefore what is valuable to preserve and develop in the future.

Lies, damned lies, and hydrological data

Peter Ede—Mott MacDonald

When I joined what was then Sir M MacDonald & Partners in 1985, the world was a very different place. Communications and computing power have changed massively, but the business environment was also very different – there was no Environment Agency, and water privatisation was still a few years off. Opportunities for UK work in hydrology were fewer than today, but I had the good fortune to work extensively overseas in the early years. Data availability has massively increased over the years, but the importance of data checking and interpretation has been a constant.

In Lombok, Indonesia, the value of even limited amounts of real data was illustrated by temporary gauging stations on two adjacent streams. One hydrograph showed frequent fluctuations while the other might have resulted from a float getting stuck but actually indicated an extremely high baseflow index. The differences were due to differential volcanic deposits, and would not have been represented by the use of an analogue gauged catchment without the real observations. Meanwhile, the benefit of talking to gauge observers, not just office staff, was illustrated by the one who explained that he kept the raingauge inside for safekeeping during the dry season!

Data issues are not just about the accuracy of available records but also how they are used. A new reservoir in Indonesia, failing to fill as expected, led to the discovery that the design stage assessment of reliable flow had been done after excluding the driest year in the 6-year flow record (for

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an apparently logical reason). Without that sleight-of-hand the scheme economics would probably not have been favourable. The process is lost, but the outcome illustrates the potential risks of compromising integrity in order to please a client or a boss.

Of course there are data issues closer to home. For example the NRFA flow record that included data from a different gauging station with a similar name, and the Met Office gridded rainfall data influenced by a factor of 10 error in converting from inches to mm for one year at one raingauge. I don't for a moment intend this as criticism of the NRFA or the Met Office; my point is that even with the best will in the world, mistakes can slip through - users should remain alert to the possibility, and get any errors corrected.

The quantities of data now available mean previous methods of checking (such as visually examining every hydrograph) may be impracticable, so new methods are needed. One example was the use of a rainfall duration curve that demonstrated the unsuitability of a set of stochastically-generated rainfall data. Generated data may show a good match to recorded in terms of monthly patterns and inter-annual variability, but if it has far fewer dry days and less extreme wet days, the resulting simulated flows will not be reliable. The conclusion - refer back to the data producers and await more appropriate data.

Some inter-generational learning that has stayed with me for nearly 30 years is the senior project manager who said, on seeing my graphs, "If it looks wrong it probably is". Always check the data!

Experiences in overseas hydrology

Marcus Francis

UK hydrologists working overseas face challenges working in different national, climatic, environmental and geographical settings. Familiar investigations and activities such as hydrometry, flood studies, low flow studies and surface water resources yield assessment may have common features, but the tools needed to address them may differ notably from those typically used in the UK. In my presentation, I gave five case studies of projects carried out since the establishment of the BHS, based on personal experience in applied research and as a consultant hydrologist.

The specific hydrological challenges in each case depended upon the nature of the project, the location, relationships with local partners, constraints in monitoring hydrological variables, data availability, an understanding of the hydrological processes prevalent in the geographical setting, and an appropriate range of hydrological tools (including alternatives) for situations where things don't go to plan.

The case studies reflect changing levels of technology, improvements in communications, the rise of the internet, the increasing significance of sustainability, social and environmental impact and the need to consider climate change. Future trends indicate greater use of remote sensing and gridded data from drones, satellites and downscaled climate change models.

Gezira irrigation scheme, Sudan (1983-1990)

This case study focussed on the development and application of flow measurement methods with low head loss, so as not to impact on irrigation practice. We used a Doppler ultrasonic approach, proprietary solar-powered data loggers, and spot measurements made using vane flowmeters designed to fit locally available pipes.

The Northern Collector Scheme, Kenya (1994 - 1998)

This study assessed the yield obtainable by diverting a proportion of the flow from seven catchments into a tunnel discharging into Thika dam, to increase potable water supply to Nairobi. We doubled the flow data record by modelling rainfall-runoff using HYSIM based on a longer rainfall dataset. Simulated tunnel outflow provided input to a water resources model, ROSS, with yield assessed using RESIZE software, both written in Fortran.

Reservoir flood studies, Trinidad and Tobago (1996)

This study derived the Probable Maximum Flood (PMF) by two methods, and a range of design events for five water supply dams. PMF was derived firstly using a hurricane model to determine the Probable Maximum Precipitation, coupled to rainfall-runoff modelling using the SCS Curve Number model. The hurricane model was developed by the US Weather Bureau for application to Puerto Rico. The second PMF assessment used the World Meteorological Organisation's statistical method to derive the Probable Maximum Precipitation (Figure 1).

Hydroelectric power projects, Ethiopia (1996-97)

Input focussed on the development of reservoir simulation models for the proposed Gojeb and Tekeze dams. The study was carried out in two stages: pre-feasibility study to consider alternative sites at each location, using preliminary reservoir models, then a feasibility study to define a cost-effective dam height/storage in relation to firm power generated using refined reservoir models. The simulation models were developed in Excel, with input flows transposed from the best available gauging stations.

Tuuyumayun dam flood study, Uzbekistan (2010)

This study determined the 10,000 year flood and Probable Maximum Flood (PMF) for the Amu Darya river at Kerki. In summer, peak flow in this river is dominated by snowmelt arising in the Pamir and Hindu Kush mountains, dependent on the temperature and depth of the snowpack laid down in the preceding winter. A regionalised flood frequency approach was adopted, based on data from 128 gauging stations located mainly in Uzbekistan and Tajikistan. This used CEH's FLOODS software. The PMF was assessed by reviewing the PMF/10,000yr ratio at major neighbouring sites, and Creager C values.

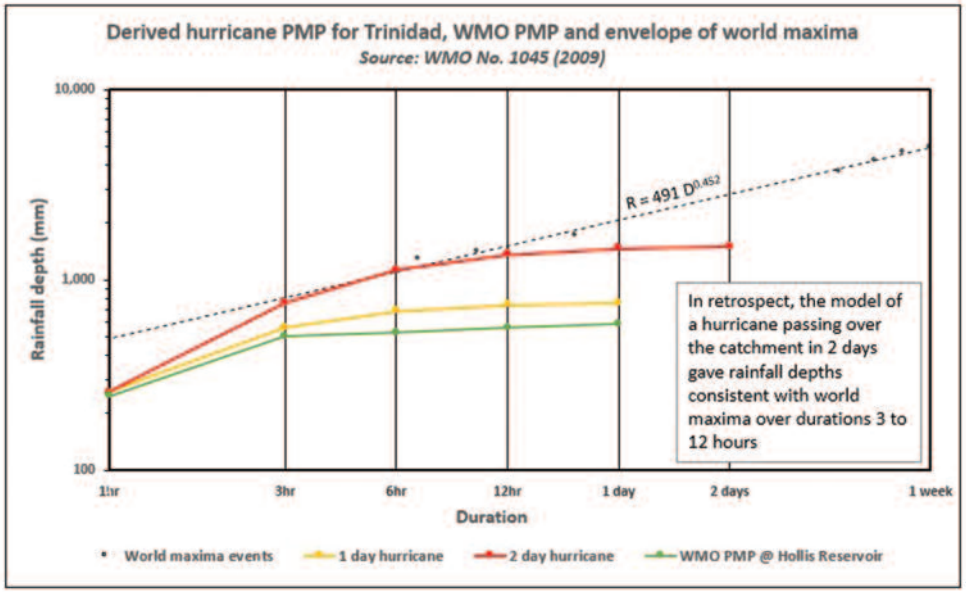


Figure 1: various Probable Maximum Precipitation curves used in the Trinidad and Tobago study.

Hydrological anecdotes

Alec Willis

I've been interested in rivers and water in general since I was at primary school. I can remember playing on a building site in Shawbury and on a beach in Torquay just making channels, diverting them, damming then breaking the dams. I was fortunate enough to be able to make a living from this childhood interest. During my career I picked up a working knowledge of flow measurement in open channels and pipes, and towards the twilight of this career the Environment Agency came up with a scheme monitoring emissions to air, land and water (MCERTS). This obliges anybody discharging pollution to a watercourse to measure the discharge, and most measurements have to be certified by an independent inspector. The target is to measure total daily volume discharged to within ±8%, using any means practicable. As an inspector I visited every county in England, as well as locations in Scotland, Wales and Northern Ireland.

About 10 years ago I went off to Norfolk to inspect the flow measurement at a maltings. One of the MCERTS provisions is that measurement facilities are inspected every five years. I remembered this site, because five years earlier I'd gone there and found the V notch was made out of quarter inch steel plate with no chamfer - I explained what needed to be done expecting to be told come back in a month or six weeks. They said “OK, can you go to the nearby pub and have a leisurely lunch, and come back at 2pm?”. I didn't take much persuading, and when I returned they had chamfered the downstream face and it conformed perfectly with MCERTS

standards. This site had a place in my heart, and the completed inspection proved it was still up to scratch.

Unsurprisingly the main change during my career in hydrometry has been the expansion of computing power. The first computer I used professionally was an English Electric KD F9 weighing 4.2 tonnes, which required an entire air-conditioned floor of the Met Office building in Bracknell. Now, to replicate the computing power in an Apple iPhone 15 with that early technology would require a machine that weighed the same as 16,000 London buses!

Recently I was evaluating two new MCERTS Inspectors, who took for granted the high resolution photo of a gauging structure, geolocated to 10m on an aerial map, taken in the field using just their phone. And to emphasise that you’re never too old to learn, the structure was a fully supressed weir, the first one I’d come across in over 1,000 inspections.



Winter low tide, River Deben estuary. H.Whittle

Conference Report on 'Scientific Advances in River Restoration'

Dr Helen Moggridge—Cartographer, and University College London

The inaugural 'Scientific Advances in River Restoration' (SARR) conference was held on 6–8th September 2023 at the University of Liverpool. The meeting was organised by the River Restoration Centre, with sponsorship from Cartographer, AECOM and University of Liverpool. 150 scientists and practitioners from over 30 countries met to share expertise and experience, discuss ideas, create new collaborations, and provide a global perspective on river restoration, to inform real-world solutions.

The conference opened each day with a keynote address from global leaders in river restoration science. **Prof. Phil Boon** (Freshwater Biological Association, UK) presented an interesting insight into how river restoration has advanced over the last 27 years, through a comparison with his conference presentation from 'River Restoration 1996'. **Prof. Kirstie Fryirs** (Macquarie University, Australia) demonstrated a methodology for measuring indicators of river recovery, and demonstrated how this can inform river management in NSW, Australia. **Prof. Ellen Wohl** (University of Colorado, US) provided a North American perspective on advances in river restoration, with an emphasis on the legacy of human alterations. These talks all provided fascinating perspectives on river restoration, showcased some key developments in the field and raised

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some pertinent questions for the future.

The conference included over 60 further papers in sessions covering the breadth of river restoration, including geomorphology, ecology, modelling, monitoring, climate change, building resilience, social partnerships and lessons learned, in addition to a popular poster session. I was grateful to have been awarded a conference grant from the British Hydrological Society and presented a paper in a session on 'Condition Assessment'. The session began with a paper presented by Dr Lucy Shuker (Cartographer) which showcased a multi-scaled, hierarchical approach for assessing geomorphic condition and for identifying restoration opportunities. My paper was titled 'Beyond River Condition Assessment: analysis of habitat survey and geomorphic river type data to provide geomorphological understanding and support river restoration design', co-authored with Prof. Angela Gurnell (Cartographer, Queen Mary University of London) and Dr Lucy Shuker. The River Condition Assessment (RCA) has multiple applications, and this paper showcased its role within the UK government's Biodiversity Net Gain initiative. Within this context, the application of the RCA for informing and supporting river restoration design was demonstrated at the reach-scale and linked into the multi-scaled, hierarchical assessment presented by Lucy Shuker. The papers were followed by an interesting, informative discussion with the audience which compared the methods with tools from other counties and provided an international perspective on river assessment approaches.

The conference was a fantastic opportunity to discover emerging research in river restoration from across the world, and in many different sub-disciplines. Some of the key themes that I noted were: i) the need to decide on river restoration priorities, recognising the legacy of human impact and shifting baselines; ii) the need for wider temporal and spatial considerations; iii) the need to recognise, and better understand, the linkages between flow, geomorphology and ecology, iv) the need for better communication of the value of restoring rivers.

Overall, the conference provided an invaluable opportunity to gain an international perspective on river restoration science, both from the presentations and subsequent discussions, and to develop networks and future collaborations. Many thanks to the organisers for such a successful conference, which will hopefully become a recurring event. My gratitude also to the BHS for their support.

A further summary of the conference and the key questions arising can be found at https://www.therrc.co.uk/sites/default/files/files/SARR/2023_sarr_conference_press_release_v2.pdf

New members of British Hydrological Society

Abbey Hewson

Alex Scott, JBA Trust

Alexandra Collyer

Alice Ambler

Andrew Cunningham

Andrew Stiles

Andrew Tabas

Angela Barber

Anthony Jones

Antonia Foley

Antonia MacDonald

Athanasios Paschalis, Imperial College London

Aziz Ul Haq Mujahid

Benjamin Francis Evans

Bertr Swart

Bryony Howlett

Catarina Henriques

Chloe Bayliss

Christina Bakopoulou

Copper Lewis

Dan Goss

Daniel Hamilton

Daniel Jones

David Morgan

Diana Golgojan

Elizabeth Barre

Emily Strathdee

Emma Bruce

Eyanae Lourien

Farzaneh Aghajani, JBA Consulting

Gareth Old, UKCEH

Gene Hammond,Penny Anderson Associates Ltd

Gianna Gavriel

Hannah Evans

Harriet Ames

Helen Rossall, Environment Agency

Isabella Tindall, UKCEH

Jacqueline Diaz-nieto, Environmental Protection Group Ltd

Jamie Randall

Jemima Hitchings, Environment Agency

Jiao Wang, University of Bristol

Joshua Kesselman

Julia Docherty, Environment Agency

Julia Knapp

Juliet Rowland

Kate De Smeth

Katie Russell

Kelly Wilkinson

Kerryn Hockley, Environment Agency

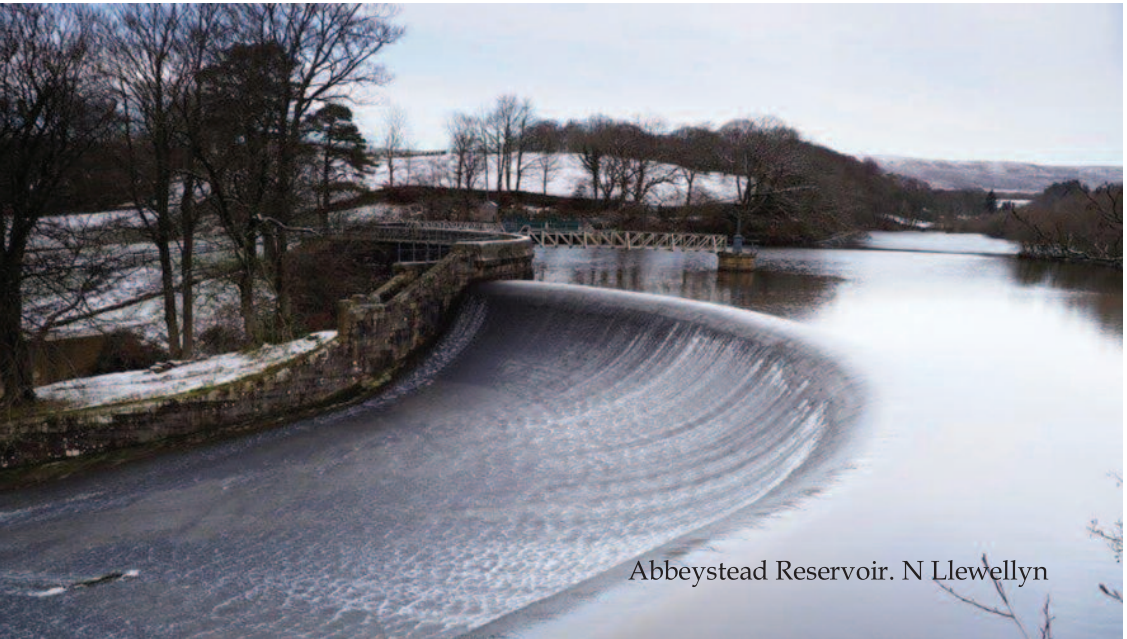
Kirstie Murphy

Kuzivakwashe Patrick Nyarugwe

Lambros Yiannacou

Lauren Brenton-Crabb

Lauriane Hoppe



Abbeystead Reservoir. N Llewellyn

Liam Durr, CH2M

Lily Woodward

Lucy Stott

Luis-Felipe Duque

Maciej Stetkiewicz

Manish Kumar, University Of Birmingham

Martin Lord, Natural England

Marty Barnfield, Environment Agency

Matthew Cowdell, JBA Consulting

Megan Patchett

Michaela Connolly

Michelle Hinfey, Environment Agency

Muhammad Javed

Nick Everard, UKC E H

Nicola Ellis

Paul Blackler, Environment Agency

Phoebe Hopkinson

Qidong Fang

Rachael Armitage

Rebecca Smith

Richard Hines

Robert Daniel Folkes

Robert Millington

Rodolfo Nobrega, University of Bristol

Safia El-Amiri

Samuel Watkiss, JBA Consulting

Samuel Brooks

Sara Trojahn, Univerisity Of Innsbruck

Sofia Midauar Gondim Rocha

Stephen Foster

Subrata Halder

Sunil Ratna Kansakar, Environment Agency

Suzanne Long, Environment Agency

Thomas Harris

Thorsten Wagener, University Of Potsdam

Trevor Bond, Environment Agency

Vanessa Hain

Vicky Crichton

Yanchen Zheng, University Of Bristol

Zeqiang Wang

Zohlunchhungi Renthlei, Environment Agency

Zuzanna Janas, Dwr Cymru

Welcome all!

Forthcoming events of interest:

25th River Restoration Conference—hosted by the River Restoration Centre, 24-25 April 2024, Llandudno, North Wales.

Peter Wolf Symposium—hosted by the University of Bristol hydrology group, 8th - 9th May 2024. The theme is 'Digital futures for observational and predictive hydrology'. A good opportunity for early career hydrologists to share their recent work on all areas of hydrology. More details in March.

BHS 40th anniversary discussion meeting: Hydrology in the 21st Century: Challenges in Science, to Policy and Practice—10-11 June 2024, funded and hosted by the Royal Society, London. Invited speakers from around the world, four themes, plus poster session.

BHS Symposium—hosted at the University of Oxford from 23-25 September 2024. An event to appeal to all BHS members, with lots of opportunities to contribute. Programme and registration details coming soon.

UK Hydrological Bulletin, August-October 2023

Terry Marsh, UKCEH Fellow

Provisionally, the August-October period in 2023 was the second warmest for the UK in a series from 1836; the Met Office series indicates an increase of 1.7C over that timespan. Rainfall totals were also very substantially above average – Northern Ireland registered its second wettest August-October on record, with correspondingly exceptional river flows. Regional, and local, contrasts across the UK were very marked. Following generally moderate runoff in early September, very cyclonic weather patterns became dominant and a cluster of three deep low-pressure systems triggered widespread and persistent flooding – fluvial, tidal and surface – with particularly extreme flows in October. The three months underline the UK's vulnerability to changing weather patterns. Transport disruption was very widespread, the resilience of many urban drainage systems was severely tested, and saturated soil conditions impacted on harvest quality, particularly in East Anglia. On the positive side, reservoir stocks generally increased – at a time when many are normally still in decline – and, at month-end, most were appreciably above average for the time of year. Similarly, groundwater levels in most index wells and boreholes were within or above the normal mid-autumn range.

At the national scale, the August rainfall total was close to the long-term average but regional, and more local, contrasts were substantial. These were generally reflected in exaggerated spatial contrasts in runoff patterns. Some rivers in Northern Ireland reported around twice their average monthly runoff, contrasting with parts of East Anglia where the river Waveney recorded only around half of its average August flow.

The arrival of storm Antoni on the 5th triggered both significant spates (e.g. in the Thames basin), and urban flooding – Belfast was particularly badly affected. Saturated soil conditions impacted on crop quality in some, mostly eastern, regions; harvesting was also delayed. Further frontal activity on the 14th brought particularly heavy rainfall to western areas. On Anglesey, 52 mm was recorded in 24hrs at RAF Mona and flood alerts triggered in Snowdonia and the Gower peninsula. Thereafter, sustained river flow recessions generally became established. However, on the 26th local rainfall intensities in excess of 32 mm/hr were recorded in Liverpool – two fatalities resulted as rising floodwater trapped the occupants of a car. In southern England, the abundant 2022/23 winter and spring groundwater recharge ensured healthy flows in many baseflow-supported streams and rivers (e.g. the Itchen and Dorset Stour) and, contrary to the normal seasonal pattern, overall reservoir stocks for England &Wales increased over the month. However, a few major impoundments, including Colliford and Roadford in the South-West, and Loch Thom in west Scotland, remained below average for the time of year.

September 2023 matched September 2006 as the warmest on record for the UK with heatwave conditions particularly extreme across the English Lowlands. High evaporative demands were initially accompanied by steep river flow recessions across most of the country (Fig 1).
A major synoptic change on the 10th then brought storms with rainfall intensities locally exceeding 32 mm/hr (e.g. in South Wales and the Lake District - Shap summit recorded

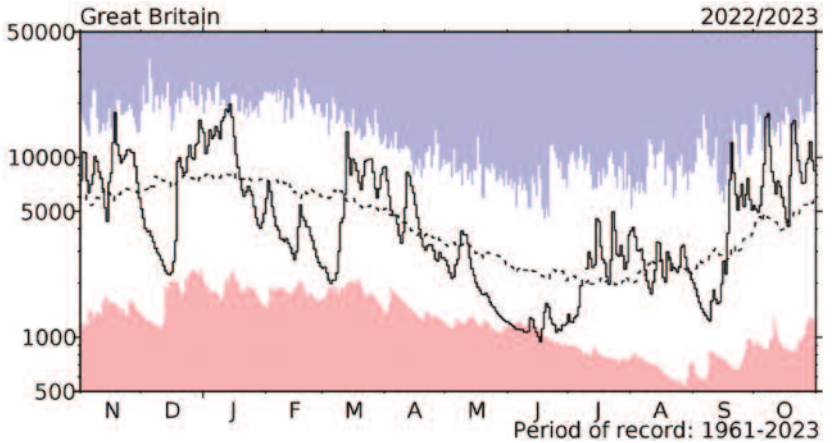


Figure 1: Daily outflows (m^3s^{-1}) from Great Britain (solid trace). Blue, red: daily extremes. Dotted trace: long term daily average.

60 mm in 12 hrs to 19.00). Flood Alerts were in operation for a number of Lake District rivers and surface flooding, with consequent transport disruption, was reported in many localities. The runoff recoveries were generally reinforced by the arrival of Storm Franklin on the 18th. In north Wales, Capel Curig recorded a 48-hr rainfall total of 175 mm late in the third week, and outflows from Great Britain approached their highest on record for the time of year. Surface flooding incidents were also widespread (e.g. in Swindon and Harberton, south Devon). Parts of East Anglia aside, many rivers remained in high spate. This was particularly true of many southern Chalk rivers - the Itchen for example – reflecting, in part, the benefit of abundant aquifer recharge through the 2022/23 winter. In Northern Ireland, the river Annacloy recorded around three times its average September runoff and exceptionally high water temperatures, together

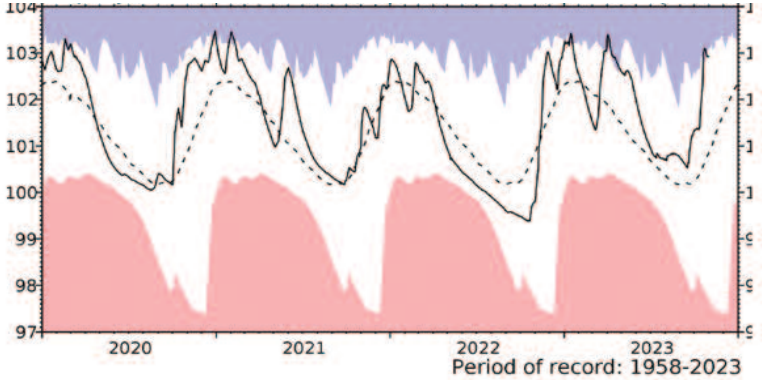


Figure 2: Ampney Crucis groundwater (black trace) in the Cotswolds Jurassic Limestone. Blue, red: long term maxima and minima. Broken trace: long-term average.

with excess fertiliser runoff, contributed to an extensive algal bloom in Lough Neagh, threatening the aquatic environment. Limited late September rainfall re-established river flow recessions. Aquifer recharge descending through the unsaturated zone ensured groundwater levels across England remained largely in the normal mid-autumn range.

Nationally, October was notably warm and exceptionally wet. The spatial distribution of the rainfall was unusual: much of western Britain registering below average precipitation whilst many eastern areas were extremely wet. October rainfall totals exceeding 500 mm were recorded for parts of the Cairngorms (Scotland), and in the Mourne Mountains (Northern Ireland). A slow-moving frontal system on the 7-8th brought exceptional rainfall and major transport disruption to eastern and central Scotland. An unconfirmed 36-hr rainfall total of 160 mm was reported for Rest and Be Thankful (Argyll), and Tulloch Bridge (W. Highlands) recorded 108.2 mm in 48hrs.

Overall outflows from Scotland were extreme during the second week, transport disruption and flood warnings were both extensive and protracted. High tides in the east were an aggravating factor (e.g. in Perth, where basement flooding was a particular concern). In England, the rivers Thames and Trent were among many approaching their highest flows for the time of year. In Northern Ireland the river Annacloy registered its highest October runoff in a series from 1979. After a lull, Storm Babet battered much of the UK early in the fourth week. Major urban flooding events were common (e.g. in Brechin and Ryde) and in Retford, on the River Idle, residents of 500 homes were urged to evacuate. Widespread and persistent urban flooding raised questions about the resilience of flood defences in many areas. The sustained and heavy rainfall did however provide abundant groundwater recharge (Fig. 2) and substantially increased stocks in most index reservoirs (Fig. 3), making for a healthy water resources outlook across most of the UK.

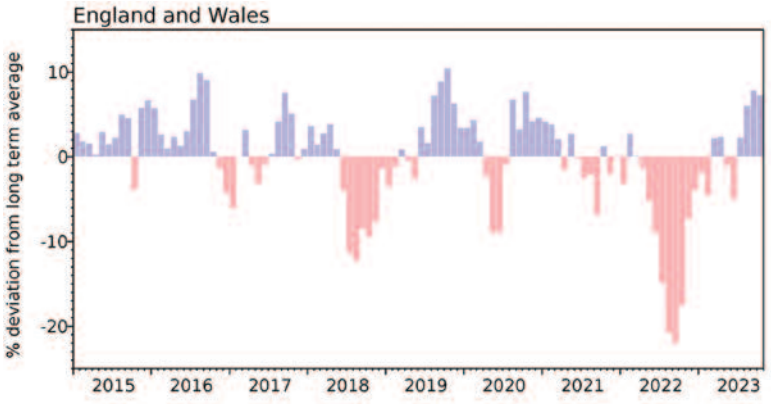


Figure 3: A guide to the variation in overall reservoir stocks for England and Wales.

UK Hydrological Bulletin, November 2023-January 2024

Terry Marsh, UKCEH Fellow

Notwithstanding marginally below average January rainfall, the UK total for the November 2023-January 2024 period ranks 16th wettest in Met Office series (from 1836) and mild temperatures reinforced the long-term warming trend for the three months – an increase of 1.2 C since 1884. The passage of a sequence of Named Storms ensured that soils generally remained close to saturation and groundwater recharge was exceptional throughout most of the period under review. With many catchments saturated by mid-October, abundant, and locally intense, rainfall made for plentiful reservoir replenishment but also triggered extensive and protracted floodplain inundations with accompanying water quality problems as contaminants were flushed back into watercourses. Flooding, both rural and urban, was particularly persistent in the southern half of Britain where groundwater baseflows remained remarkably high from early November. Transport disruption was very substantial, particularly in Scotland where snowfall was an aggravating factor. Overall, the three-month period served to underline the UK's increasing hydrological vulnerability in a warming world. That said, fatalities associated with the flooding were fortunately few – and very moderate in global terms. Flood prevention measures – particularly in some urban areas – proved inadequate but mitigation measures clearly reduced the scale of the flooding. The floods did serve to focus attention on the ecological risks of contaminant-rich flood waters draining back into the river network

Circulation

Following the sixth wettest October on record much of the UK was very vulnerable to further rainfall and, whilst November rainfall across most of the northern half of the country was less than 70% of the monthly average, southern England experienced an exceptionally wet month – notably so in Kent. The arrival of Storm Cirian in the first week triggered around 80 Flood Warnings across the country. In Northern Ireland – where Glennane reported a 72-hr rainfall total of 99 mm – severe flooding was experienced in Newry, Downpatrick and Portadown. With soils mostly remaining close to saturation, many southern rivers in England registered more than twice their average monthly runoff.

Unusually heavy suspended sediment loads were widespread and sustained – compromising the effectiveness of some water treatment works - at Shalford on the river Test in Hampshire bottled water was supplied to meet consumer needs. On the 13th, Storm Debi triggered further flood warnings and reinforced an exceptionally steep rise in groundwater levels across much of England. At Chilgrove, in the South Downs, levels in the Chalk rose over 30 metres in a week and at Rockley (Wiltshire) they remained exceptionally high throughout the month (Fig. 1) and most index wells across England substantially exceeded their late-autumn average.

Cyclonic weather patterns dominated an unsettled but exceptionally mild December. The passage of four named storms contributed to the 4th wettest December since 1929 for the UK as a whole; particularly high rainfall totals were registered in many eastern catchments. River flows generally

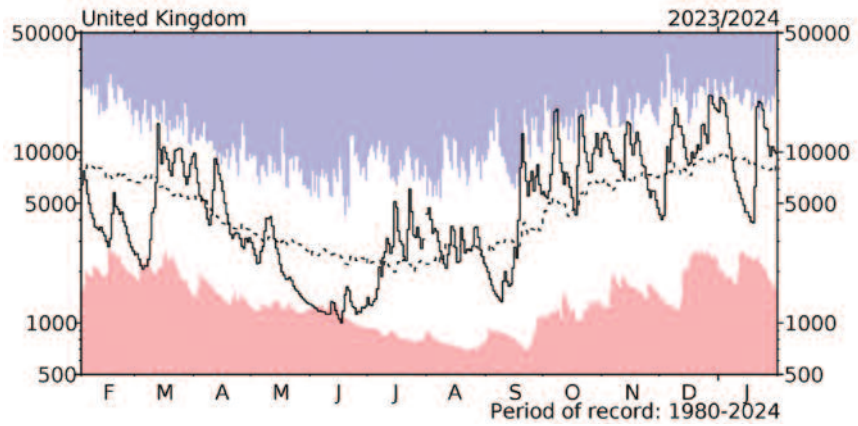


Figure 1: Daily outflows (m^3s^{-1}) from the UK (solid trace). Blue, red: daily extremes. Dotted trace: long term average.

increased steeply in the second week due to the passage of Storms Ellin and Fergus. In north Wales a 71mm rainfall total was recorded over three days at Lake Vyrnwy and transport disruption was both widespread and protracted. Saturated ground conditions contributed to a series of landslips – for example, near Ventnor on the Isle of Wight. With high pressure then dominant, rivers generally remained in recession until the arrival of Storm Gerrit on the 27th. This brought heavy precipitation to almost all areas. In northern England a 72-hr rainfall total of 98 mm was recorded at Shap; Tulloch Bridge (north Scotland) reported 81mm. Flood Warnings were very extensive across the UK particularly in Scotland where Glasgow was badly impacted and in Cupar (Fife) many residents required rescuing from their homes.

Most index rivers recorded more than 150% of their average December runoff; the River Deveron (Scotland) and Stringside Stream (East Anglia) were among an appreciable minority registering their highest December runoff on record.

Groundwater recharge was also exceptional. In the Jurassic Limestone of the East Midlands the New Red Lion borehole recorded its highest level in a 60-year series; near-record levels were widely reported across the UK. By month end, reservoir stocks were at capacity in over half the index reservoirs, an unusual circumstance for the early winter. This made for an encouraging water resources outlook but with very little available storage to help moderate downstream flood risk in early 2024.

January was another very mild month with UK rainfall close to the national average albeit with a few areas, including parts of Northern Ireland and western Scotland, registering less than 70% of average. Of greater hydrological significance was the exceptional intensity of precipitation during the first week in many areas. By the 4th many 72-hour rainfall totals had exceeded 70 mm - and soils were generally saturated. Over 300 Flood Warnings were in operation across the UK with multiple warnings along many major rivers including the Thames, Severn, Trent, Spey and Warwickshire Avon. Initial assessments of return periods were in the 10-20 year range and floodplain inundations were both extensive and protracted. Particularly extensive flooding was reported in Nottinghamshire and Worcestershire.

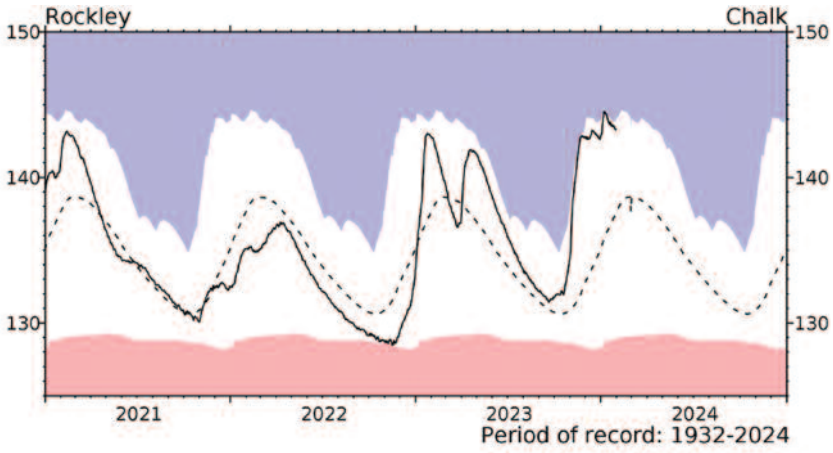


Figure 2: Groundwater levels in the Chalk at Rockley (black trace). Blue, red: long-term maxima and minima. Broken trace: long-term average .

Outflows for England, Scotland and Wales closely approached the highest on record for the time of year and thousands of acres of farmland were underwater. The Environment Agency reported over 1000 homes flooded but fortunately steep recessions in rivers draining impermeable catchments became established in the second week.

In contrast, many groundwater-fed rivers and streams remained in high spate – the Lud in Lincolnshire registering more than twice its average January flow and flood warnings persisted well beyond month-end in some southern Chalk rivers. Entering February, stocks in most index reservoirs across the UK exceeded 90% of capacity making for a healthy water resources outlook.

Circulation

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.



Bankfull river near Clun. J. Allsopp

Notes

British Hydrological Society

1983-2024