

Circulation

No.153
May 2022

The Newsletter of the British Hydrological Society

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BHS2022 14th National Hydrology Symposium

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Hydrological Bulletin : March – May 22

Copy deadline for Circulation No. 154 28th July 2022

Circulation **is published quarterly. It is free to members of the British Hydrological Society and costs £25 to nonmembers on annual subscription. Articles published reflect the views of the authors and do not represent official BHS policy.**

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Circulation **is indexed in** *Geosystems' Hydrotitles* **&** *GeoArchive* **and** *NISC HydroROM*.

President's Perspective

Working together for change

A relatively short piece from me this quarter, but I have to say, as for many of you I expect, it has been wonderful to start to meet with colleagues and friends in person again after two years of meeting only through screens. The BHS Committee are in the process of planning national meetings and we hope to restart these in person soon as well as reviving the popular BHS Webinar programme – so if you would like to volunteer to organise a meeting, propose a topic or to give a webinar (or propose someone else!) then we'd be delighted to hear from you, the membership.

Within the BHS Committee we have been talking a lot about the governance of the Society, with a comprehensive review recently produced by Chris Skinner. We will share this with the membership in due course for your inputs and guidance on what you want, but modernising some of the internal procedures will help us all in being more efficient and working more effectively together.

So, just a few more things. I do hope that you are all planning to register for our postponed Symposium, due to happen at Lancaster University on 12-14th September 2022. The BHS Symposium will consist of a series of in-person networking events and sessions organised in five themes across the three days. These themes are: (a) Future hydrology, (b) Floods & droughts, (c) Natural flood management & partnership working, (d) Ecohydrology & water quality, and (e) International hydrology. The symposium will also include field visits, demonstrations and talks in the Lake District (Cumbria) on the 14th. Please do consider attending and meeting your fellow hydrologists in person. We are still accepting abstracts so please do submit soon.

For early career hydrologists, please also consider attending the in-person Peter Wolf Symposium from March to 20-21 September 2022. The theme is Hydrological Innovation for the Climate

Emergency and will be run over two days in Glasgow. It will include a mix of oral and poster sessions from the early-career delegates, invited keynote speakers, and a site visit. There will also be an evening dinner/social event on the Tuesday. Please see the Symposium website for more details.

The Flood Hydrology Roadmap is now finalised and published - https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/flood-hydrology-roadmap. This sets out a vision for flood hydrology for the next 25 years and is key to ensuring UK water resilience, with many of its priorities around increased community collaboration; sharing data, models and best practice. I am on the FHRM governance board and the BHS has agreed to help with some of the FHRM priority actions, particularly through access to our membership, so do watch out for surveys etc coming through the mailbase, Twitter etc. and please engage with these if you can.

We have a number of openings on the BHS Committee – Honorary Secretary and 3 Ordinary Members - we would be delighted to receive a number of nominations for these posts. The Society is what we make it.

Please do get more involved; if you would like to find out more then contact anyone from the Committee.

Hayley Fowler
BHS President,
May 2022

Corrections

Please be aware that the article in Circulation 152 titled "Easy methods for quantifying the uncertainty of FEH pooling analysis" had a mistake in equations three and four. The QMED and LCV should be multiplied rather than LCV subtracted from QMED. This has been corrected in the version available online (https://www.hydrology.org.uk/publications.php). Apologies!

Anthony Hammond

Our last issue also had a valuable contribution from Dave Archer on 'Puzzling non-stationarity' which your careless Editor embarrassingly attributed to Terry Marsh. Both authors have kindly accepted my sincere apologies and I have altered the file copies of Circ. 152 accordingly.

Celia Kirby



Fourteenth National Hydrology Symposium

Mon 12 – Wed 14 Sep 2022
@Lancaster University & Lake District

Why participate?

- Chance to share you latest research or practice with the UK hydrological community
- Opportunity to chat with internationally-respected leaders in hydrological modelling, hydrometry, eco-hydrology, water quality or socio-hydrology
- Informal atmosphere to discuss new ideas in-person
- Chance to meet socially with old friends or develop your academic and practitioner networks (particularly after 2 years of restrictions)
- Listen to presentations from both science and engineering fields and ask questions publically or over a coffee
- Interact with exhibits and demonstrations of new tools or materials for research, teaching or practice
- Hear about new national initiatives linked to the symposium themes of Future hydrology; Floods & droughts; Natural flood management & partnership working; Eco-hydrology & water quality; International hydrology
- Contribute to in-person panel discussions (programme being developed for advertising this summer)
- Undertake hands-on fieldwork and field visits in stunning locations of the Lake District (transport provided on Wed 14 Sep); further details of the programme published this summer

How to register, submit a presentation and/or book accommodation?

All details and links available on the BHS2022 webpage:

www.lancaster.ac.uk/bhs2022

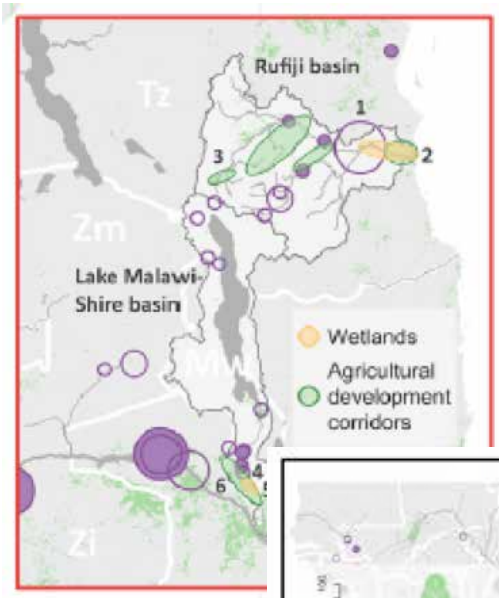
BHS–Hydrology's crucial role in addressing global environmental challenges

I enjoyed the new President's Perspective in Issue 151 (Transdisciplinarity and working together for change) and it got me thinking about my own work on climate adaptation - particularly how hydrology underpins so much transdisciplinary research on global environmental challenges. My first degree was in Geography with a major in hydrology (at Swansea, inspired by the indefatigable Prof Rory Walsh) and while I've spent much of my subsequent career working on water and climate related topics in the context of adaptation, it sometimes feels like I've drifted a long way from hydrology itself.

However, reflecting on this reminds me just how important the underlying science and hydrometry is to what the global change community does. To illustrate this I consider a recent paper which for me encapsulates many of the aims that the President identified in her address – the need to build resilience, co-develop solutions, provide information on risk and promote collaboration.

The paper is titled 'Climate variability impacts water-energy-food infrastructure performance in Eastern Africa' – it draws together insights from collaborating partners that formed a consortium within a larger research programme called Future Climate for Africa. Alongside my geography roots, the author mix includes social scientists, climate/environmental scientists and hydrologists/engineers. The programme aimed to examine the case for and, where relevant, promote methods to integrate climate change risk into decision-making and long-term planning. We designed research we felt would address this goal and required a diverse suite of activities, that all fall within the remit of adaptation. This required a mix of science to better understand the climate/hydrological systems, modelling to simulate the river basins' response to pertur-bations, and social science to understand how decisions are made and by whom and to establish the types of information that would be useful for decision-makers. The paper draws this together and makes practical recommendations for climate risk management - the transdisciplinary element.

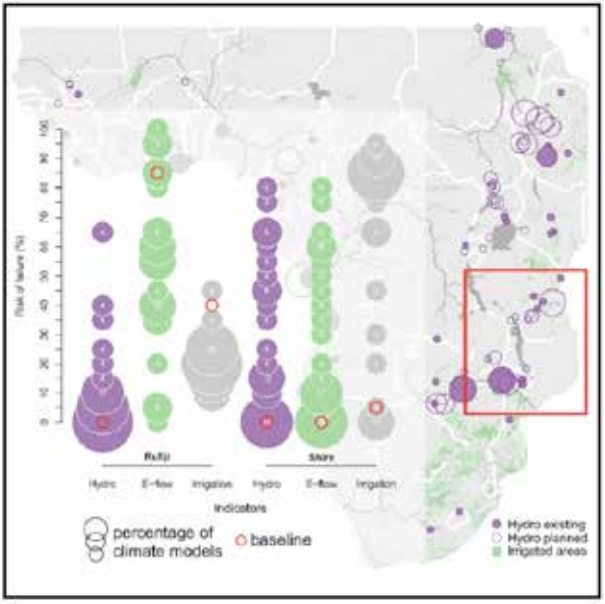
Our work focused on the Rufiji River basin in Tanzania and the transboundary Lake Malawi – Shire River basin (LMSRB). Both basins are large, with a range of interesting hydrological features including major wetland systems with high biodiversity/tourism value. Lake Malawi is Africa's 3rd largest lake and overflows in the Shire River, a tributary of the Zambezi River. Historical records show an outflow threshold which was passed during a dry period in the early 20th century stopping outflows into the Shire River. Both basins are economically very important at the national level and are earmarked for ambitious development plans, including expansion of hydropower and irrigation. In the Rufiji, the Julius Nyerere Hydropower Plant is the second largest in Africa currently under construction. As such, they exemplify current challenges in many river basins of the global south with rapidly developing resource use and



interdependencies between water use across sectors and within a connected river basin. We are increasingly aware of the need to represent multi-sector interdependencies in decision-making.

What did we find?

We focused on the past and near term future – which is crucial to achieve traction with decision-makers and relevance for operational decisions - and examined how climate change might impact reliability indicators



new infrastructure all happening in a changing climate.

To make the work resonate with decision-makers we identified through extensive consultation some critical system performance measures to capture in the models and then assess how climate change might impact them. In addition to looking forward we looked back and ran both models with historical gridded observations, assuming the planned infrastructure had been built to assess performance under a 'what if' scenario. To achieve an integrated analysis we considered water in the context of its role in energy generation through hydropower and in food production through irrigated agriculture, recognizing the crucial of electricity generation from hydropower, irrigation water supply and river flows for environmental needs.

Both basins had high sensitivity to multi-year droughts which we know have occurred in the past and would challenge the reliability of proposed infrastructure. While projected risks for the Rufiji River Basin were similar to those of the present day, future risks exceeded those experienced during the 20th century for

the Lake Malawi-Shire River, particularly likelihood of failure to meet irrigation water requirements.

Where does the hydrology come in?

All the science and modelling are underpinned by observations (even if they are buried in the gridded input datasets we use) which are vital for the whole exercise. In situ observations in much of Africa are increasingly sparse (flow measurements for the Rufiji main stem are only available for a short period in the 1970s) and while great progress is being made in remotely sensed data sources, we still urgently need development of low cost reliable sensors for use in remote locations that have crucial hydrological importance.

The LMSRB has been modelled before but recent upgrades to its outflow barrage have not been included so we spent considerable time trying to untangle the effects of rainfall variability and barrage management decisions in the lake water balance and outflows, as there are sparse observations for the former and limited documentation of the latter. For the Rufiji we used a well-known global model (LPJmL) and made a detailed assessment of its performance, which although quite good (considering the stringency of the test) still required considerable modification before we felt confident in simulating the system. Nevertheless we made some big assumptions about wetland behaviour due to lack of observations. This type of cross-scale modelling is helpful in diagnosing issues with global hydrological model performance to help improve them, assess their reliability for particular rivers and establish how much confidence we can place in their results.

Many of the management recommendations related to early warning and contingency planning for multi-year drought/high flow conditions and these require technical hydrological capacity. For example, linking weather observations/forecasts with hydrological models, interpreting risk factors for system performance and designing contingency decision processes for reservoir and lake barrage releases.

Finally, in our efforts to achieve a transdisciplinary research process we engaged widely with hydrologists practicing in ministries to co-develop the work, access data, and get advice and guidance on how this new knowledge could be made useful in practice. The last aim brought all of us to some extent into this new transdisciplinary space which, as noted in the President's Perspective, represents a fertile area for defining and answering questions that matter for society. However, we don't all need to do the transdisciplinary work – but for those that do it's important to recognize the role that disciplinary research makes – and to celebrate the contribution that hydrology and the BHS makes in ongoing efforts to address global environmental challenges – thank you!

Declan Conway
Grantham Research Institute on Climate Change and the Environment
London School of Economics and Political Science

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Impacts of snowmelt on Probable Maximum Flood estimation

The Probable Maximum Flood (PMF) estimate is used for assessing reservoir safety under the Reservoirs Act (1975) for "Category A" classified reservoirs. Winter and summer season floods are estimated and compared to find the worst-case scenario. The winter estimate includes an allowance for snowmelt rates.

There are two methods available for estimating snowmelt rates:

1. A standard 42 mm/day rate prescribed in the Flood Studies Report (1975). It is widely acknowledged that this may be a significant underestimation of rates in some locations and conditions.

2. A geographically variable rate that can be calculated following the methods set out in a paper by Hough & Hollis (1997). This comprises three steps:
   a) Estimating the 5-year snowmelt rate
   b) Scaling up to the 100-year snowmelt rate
   c) Adding an allowance for the impact of rain on snowmelt rates, which depends on the rainfall rate and therefore gives a different snowmelt rate in the antecedent period compared to during the PMP storm itself.

The Floods & Reservoir Safety 4th Edition guidance (ICE. 2015) recommends checking for sensitivity to snowmelt rates in areas where Hough & Hollis (1997) indicated that rates higher than 42 mm/day might be expected.

Recent work within the Environment Agency and wider discussions have indicated that some PMF estimates are in higher rate areas are still only using a 42 mm/day snowmelt rate with no sensitivity checks, and those studies that are applying Hough & Hollis (1997) may be doing so incompletely by not including an allowance for the impact of the energy within the rainfall on snowmelt rates. This is partly due to a lack of available software to apply the Hough & Hollis (1997) method in full. The potential implications are that PMF at sites sensitive to higher snowmelt rates may be underestimated.

To assist PMF calculations including the full Hough & Hollis (1997) method, the Environment Agency have released a method restatement (worked example) and a spreadsheet tool. Both can be requested from the National Flood Hydrology Team at

FloodHydrology@environment-agency.gov.uk.

The spreadsheet includes a number of assumptions to automate the calculation, including selecting a climate station for the 100-year / 5-year growth factor for snowmelt rates based on the nearest catchment centroid.

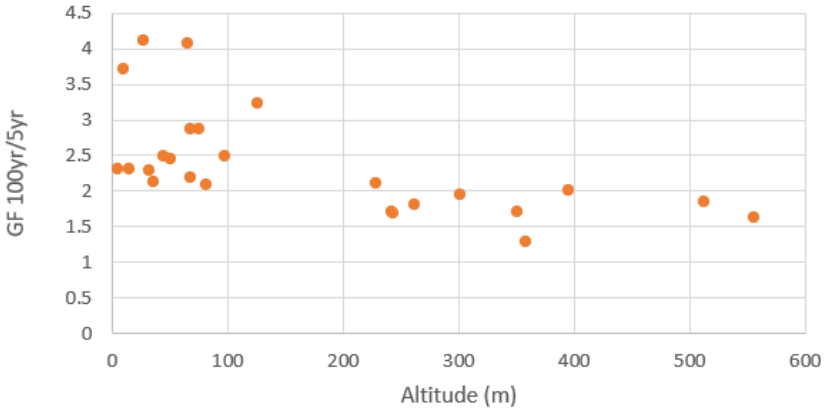


Fig. 1. 100-year / 5-year growth factor for snowmelt rates, plotted against altitude

However, altitude can also affect snowmelt rates due to factors such as wind speeds, temperature, humidity, turbulence, and consolidation of the snow. The available data indicates that higher altitude sites tend to have lower 100-year / 5-year growth factors (Figure 1). Analysts may wish to consider this when selecting a climate station, as well as other assumptions made in the automation. The spreadsheet can be unlocked and edited to allow analysts to explore the impacts of assumptions in the calculation.

This work has been completed by JBA Consulting as part of the Defra/EA FCERM R&D research project "Improving Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) estimation for reservoir safety". Phase 1 of this project will be published later this year. For more details please see https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/improving-probable-maximum-precipitation-pmp-and-probable-maximum-flood-pmf-estimation-for-reservoir-safety

Clare Waller
National Flood Hydrology Team,
Environment Agency;

David Price,
Director of Hydrology and Climate Hazards,
Jacobs

References:

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NRFA Review of the Year:

The UK Surface and Groundwater Archives Committee (SAGA) convened for its 39th annual meeting held on the 2nd March 2022.

The SAGA Committee comprises representatives of organisations from across the UK involved in the measurement, management or use of hydrometric data. This year's meeting was attended by members of the UK Centre for Ecology & Hydrology, British Geological Survey, Scottish Environment Protection Agency, Environment Agency, Natural Resources Wales, Met Office, Canal & River Trust, Welsh Government, British Hydrological Society, Chartered Institution of Water and Environmental Management and representatives from the UK water industry. Amongst the items discussed at this year's meeting was a review of the activities of the NRFA over the last 12 months.

As normal, the NRFA's activities have included updating and ongoing maintenance of the nation's central database for hydrometric data. Ensuring that the Archive is up-to-date involves an intensive programme of year-round work to quality control new data before it is added to the Archive, as well as reviewing existing data. The NRFA's core daily mean flow dataset alone was subject to around 330,000 updates and changes in the last 12 months. With the continuation of the COVID-19 pandemic, unfortunately for a second year running our usual liaison visits with our colleagues in the Measuring Authorities could not go ahead as planned – we hope that will change in the coming year!

The annual update to the Archive this year contained data for the water year 2019/2020, which included several new record flows across the UK. These new record flows were recorded at a number of stations across Wales and the Midlands during the winter of 2019/2020 and were documented in our blog posts and open-access paper published in the journal Weather.
Alongside the routine update to daily flow data, an annual update to peak flow data as well as a period of record review of a subset of peak flow stations

led to the release of Version 10 of the NRFA Peak Flow Dataset, and some 3,500 station years of data reviewed.
NRFA staff continued to liaise and engage with key stakeholders and the user community, with online seminars for the British Hydrological Society and Centre of Excellence in Environmental Data Science. The NRFA website remains very popular and has seen sustained activity in 2021/2022. There were around 25,000 downloads of river flow, spatial and metadata and around 750,000 page views by 80,000 users across all pages on the NRFA website. The NRFA API has also seen sustained usage with data downloaded just under 500,000 times.

The National Hydrological Monitoring Programme (NHMP), operated jointly by the UK Centre for Ecology & Hydrology and the British Geological Survey has continued to publish the monthly Hydrological Summaries for the UK. The NHMP analyses of NRFA data also contributed to three peer-reviewed papers on the drought in 2018/2019 (Turner et al., 2021), the flooding of 2019/2020 (Sefton et al., 2021) and an updated analysis of UK-wide flood trends (Hannaford et al., 2021). The NHMP published hydrological status updates commenting on the water resource situation.

Isabella Tindall, Head of the NRFA commented "2021/2022 has been another successful year for the NRFA, with a number of important outputs and updates to our services along with the publication of several papers and blog posts. At the SAGA Committee meeting our plans for the next 12 months were discussed. They include continued improvement to our tools, encompassing the development of systems to read data from the Measuring Authority's APIs and for publishing and archiving database versions in a way that may enhance reproducibility of analysis and research."

Steve Turner

Hydrology Research

You may remember that IWAP kindly sponsored a set of APC waivers for BHS members.

The latest one to come out is: https://iwaponline.com/hr/article/doi/10.2166/nh.2022.005/88593/Dramatic-growth-of-hydrological-science-in-the-UK

Review of fluvial flood frequency estimation in groundwater-dominated catchments

Background
Following some challenging projects estimating flood flows in highly permeable catchments, the Environment Agency commissioned JBA Consulting to undertake a review of fluvial flood frequency estimation in groundwater-dominated catchments. The review considered:

- What and where are groundwater-dominated catchments
- Flood-generating processes in groundwater-dominated catchments and example events
- The challenges of flood frequency estimation in groundwater-dominated catchments
- The performance of FEH methods on groundwater-dominated catchments
- Alternative methods for flood frequency estimation
- Recommendations for current practice and research

This report is now available to download by emailing

FloodHydrology@environment-agency.gov.uk

or download via JBA's website

https://www.jbaconsulting.com/knowledge-hub/exciting-new-research-into-flood-frequency-estimation-in-groundwater-dominated-catchments/

Summary
We have moved away from referring to "permeable" catchments, because all catchments are permeable to some degree and understanding the sub-surface flow processes is important throughout hydrology. For this review, groundwater-dominated catchments are defined as catchments where the river flow is dominated by contributions from groundwater, i.e. baseflow. A dominance of baseflow implies a close connection between surface water and groundwater. A threshold of BFI (baseflow index) ≥ 0.66 is proposed to define a catchment as groundwater dominated. At ungauged locations, BFI can be estimated from the HOST dataset of soil properties, as the catchment descriptor BFIHOST or the newer version BFIHOST19.

Most UK catchments above this threshold are in the south and east of England. The majority, and those with the highest BFIHOST, are dominated by outcrops of chalk. Others are found in areas of Jurassic limestones and Triassic sandstones. Although they can behave more similarly to lower-permeability catchments, the study also covers karst catchments, not all of which have a high BFIHOST.

Fluvial floods on these types of catchments can arise from a variety of physical processes. These include flash flooding, baseflow-dominated flooding and karst flooding. Combinations of processes can also occur,

particularly on catchments with mixed geology or some urban land cover. Six challenges for flood frequency estimation in groundwater-dominated catchments were identified:

- Difficulty defining the contributing catchment area
- Changes in processes between smaller and larger floods
- Ephemeral streams
- Annual maximum flows that are not floods
- Non-stationarity
- Long-lasting floods

A consequence of these challenges is that the FEH methods show some evidence of higher uncertainty in groundwater-dominated catchments. Both the Statistical method and the ReFH2 rainfall-runoff method are affected in similar ways, although ReFH2 also faces the difficult of predicting hydrograph shapes and volumes when the flow may depend on a complex combination of antecedent conditions.

Other non-FEH methods that could be applied to groundwater-dominated catchments include continuous simulation, making use of outputs from groundwater models, joint probability analysis in mixed flood response catchments, sewer modelling of karst, and using evidence from geomorphology. These approaches have their own methodological advantages and disadvantages, uncertainties and cost and time implications.

Recommendations

The Environment Agency's Flood Estimation Guidelines already give some recommendations for flood estimation on groundwater-dominated catchments. This review found no need to fundamentally modify these recommendations, but emphasised the importance of understanding catchment geology, hydrogeology and flow processes in flood conditions. More priority than usual should be given to local flow and river level data, valuing historical data and understanding flood volume. The Flood Estimation Guidelines will be updated to include the review's recommendations for current practice.

The review also identifies many possible avenues for further investigation. These are grouped into four work packages:

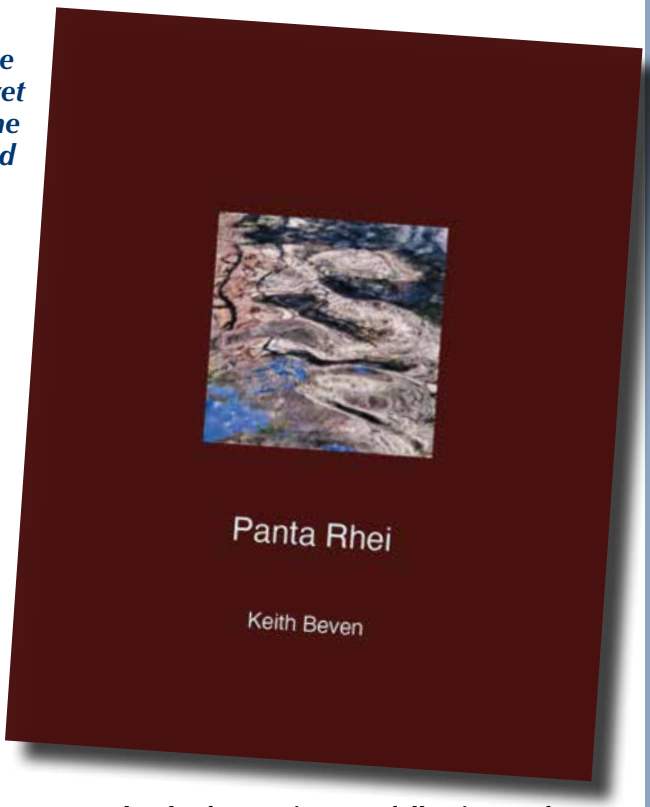
1. Explorations and tests on a small sample of gauged catchments where the FEH ungauged catchments methods give particularly poor estimates. This could include considering hydrological contributing areas, alternative catchment descriptors, and applications of multivariate methods.
2. Analysis of all groundwater-dominated catchments, including considering using river flow data from chalk areas in Northern France, deriving an alternative QMED equation, data transfer guidance, and specific pooling group methods.
3. Testing and refining the ReFH2 rainfall-runoff model.
4. Collating existing information and developing guidance, including exploring the value of historical flood data and long term records of groundwater level, providing guidance on applying design event methods in mixed response catchments, and developing case studies for alternative methods such as continuous simulation.

Funding opportunities for further research in these areas are being investigated. We are keen to work with the wider community to progress some of these ideas, for example through PhD or MSc dissertation projects. For further information, please contact the National Flood Hydrology Team at FloodHydrology@environment-agency.gov.uk

Duncan Faulkner
Head of Hydrology, JBA Consulting
Clare Waller
National Flood Hydrology Team, Environment Agency

"We get into the same river and yet not into the same river, we are and we are not [the same]."

— Heraclitus



This is Keith Beven's new book of water images, following on from the success of the first book '*The Still Dynamic*', which sold out rather quickly in its limited edition print last year (though it is still available to download as a pdf from the mallerstangmagic.co.uk shop).

This new volume contains (mostly) more recent pictures from some of his favourite places in the UK and Switzerland including, of course, the Mallerstang Valley in Cumbria.

Are 'Walls of Water' Kinematic Shock Waves?

Walls of Water (WoW) have many of the characteristics of kinematic shock waves, in the vertical or near-vertical wave front and rapid increase in both level and discharge with a total of nearly 300 historic and recent events described in the chronology of flash floods (Archer and Fowler, 2021).

Until recently the real world occurrence of such WoW or shock waves have been doubted in spite of the theoretical basis for their existence. Lighthill and Whitham (1955) recognized the intrinsic nonlinear property of flood waves and the associated shock potential. Flood wave celerity is a direct function of discharge, and consequently, larger flows travel faster than smaller flows. Numerical computation confirms this seemingly natural property of flood waves. This tendency results in the rising limb of the hydrograph to steepen, eventually leading to shock development. However this tendency is counteracted by hydrodynamic dispersion and flood attenuation so that shock waves are uncommon. However, distinguished engineers state that they are elusive or very rare.

Henderson (1966) indicates that shocks are simply a result of the approximations made in the development of the theory. Similarly, Kibler and Woolhiser(1970) state the following: 'While the shock wave phenomenon may arise under certain highly selective physical circumstances, it is looked upon in this study as a property of the mathematical equations used to explore the overland flow problem rather than an observable feature of this hydrodynamic process'. Ponce and Windingland (1985) note that:

'This apparent pervasiveness of the kinematic shock in the computational laboratory lacks a parallel in the real world It is widely recognized that only under very unusual circumstances is the kinematic shock likely to develop in actual practice. Furthermore, well documented instances of sightings are almost nonexistent'.

With the compilation of historic and recent events described in the chronology of flash floods events which resemble kinematic shock waves can hardly be described as rare. Recent event in the Pennines have gauged records. Several possibilities arise.

1. I have been over generous in ascribing events to 'walls of water' in the basis of historical descriptions in the Flash Flood Chronology at https://www.jbatrust.org/how-we-help/publications-resources/rivers-and-coasts/uk-chronology-of-flash-floods-1/. This is possible for a few events but even if half of them were eliminated that still leave a sizeable set of events.
2. Hydraulic specialists have mistakenly assumed that extreme sudden rates of rise in rivers were the result of upstream dam break of ephemeral landslides or collapsed bridges, for example

with respect to the Boscastle flood in 2004 and Lynmouth in 1952. There is now good evidence that rapid rates of rise in rivers in the UK do not need such upstream blockage.

3. Hydrologists have been so focused on the hazard of peak level that they have overlooked the occurrence and hazard of rapid rise (which can be deadly) except on very rare occasions when extreme rates of rise combine with extreme peak.
4. The general use of a 15 minute interval for river level and flow measurement does not permit the identification of a sudden or near sudden rise in level. The alternative of personal non-professional observation and report is not accepted as rigorous evidence

The evidence of WoW in Britain is now matched by evidence from recent papers by Viggiani (2020) who lists 20 'instant floods' from various parts of the world which caused death by drowning. Similarly Collischonn and Kobiyama (2019) note the relatively frequent occurrence of 'cabeça d'água' in southern Brazil as a type of flood in which it is possible to clearly observe the arrival of the flood wave as a visible discontinuity of flow and water level.

Monitoring and forecasting of such events need to be given more prominence in Britain whether or not they are kinematic shock waves. We must not wait until another Lynmouth or Boscastle flood occurs.

David Archer

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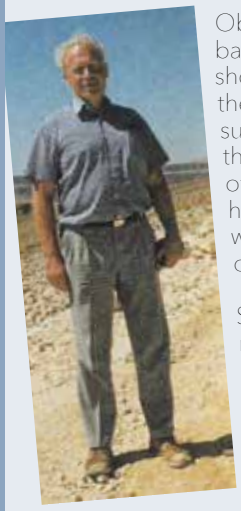
Viggiani, G. (2020) The elusive topic of rainfall-induced surge waves in rivers: lessons from canyon accidents, Int. J. River Basin Manage., **10**.1080/15715124.2020.1760291, (1–15).

New members

Lucy Archer Lock.....Oxford University
Jamike Brown.....Carlisle
A Chevutiri.....UKCEH, Wallingford
Timothy Cross.....Carmarthen
Oludare Durodola.....Aberdeen University
Alex Fraser.....Northumberland County Council
Tim Howson.....Ilkley
Alannah Killeen.....Reading
Edward Malone.....Exeter
Cain Moylan.....JBA Consulting, Bristol
Nikos Taktikos....Environmental Protection Agency, Dublin
Ryan thompson.....Newcastle upon Tyne
Michael Wortmann.....Oxford University

Obituary

Mike Mansell-Moullin died peacefully at home in Chagford, Devon on 26 January 2022, aged 95. He was the driving force behind the formation of the British Hydrological Society and was appointed as its inaugural President.

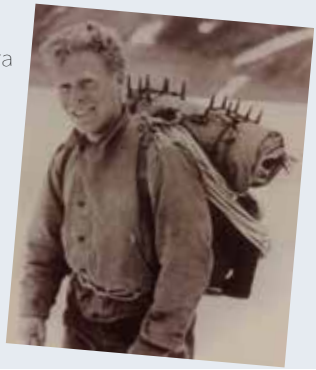


Observing that hydrologists come from a wide range of backgrounds and interests, he was clear that the new Society should steer a middle course between the academic and the applied. To that end, he secured the endorsement and support of the Institute of Hydrology (as it was then) and the Institution of Civil Engineers to represent the interests of the two wings respectively. He was himself an 'applied' hydrologist from a geographical science background which allowed him to appreciate both equally. His life and career help to explain how this duality was formed.

After a happy 4 years as a boarder at St Edwards School, Oxford. During his last 2 years he greatly enjoyed rowing; it gave him a little freedom as he had to bicycle across the meadows to the boathouse on the River Thames. He remembered on one occasion, coming back from the river to find soldiers setting up a Bofors Anti-Aircraft gun near the meadow edge. They let the boys sit on it and traverse and elevate the barrel! The influence of the War was of course ever present. Mike would spend weekly periods in the workshops drilling holes in metal pieces for Spitfire fighters, and filing the rough edges. Double digging a school field, as part of the 'Dig for Victory' campaign, was also enjoyed and endured!

During the summer of 1944 he volunteered to join the Royal Engineers, and the following September he became a soldier (No. 14401551)! He spent 6 months attending the 9th Royal Engineers University Course in Birmingham, followed by a long period of army training firstly at Clitheroe in Lancashire.

Two year's of training later began the start of active service. In 1946 he boarded the troopship 'Britannic' bound for Bombay, and was posted to the King George Fifths Own Bengal Sappers and Miners. At this time tensions throughout India were rising, and rioting and massacres were taking place in the run-up to Independence Day, 15th August 1947, when Pakistan, both East and West, came into being. Mike volunteered to stay on for an extra year and in 1949 was de-mobbed with the rank of Captain, aged just 22. He had been accepted by the Forestry School at Oxford University but the requirement to take a Latin exam put him off so instead he started (for less than a day) an Agriculture degree at Cambridge. He then transferred to the Engineering Department, before finally settling on the Geography Department. Having done research into glaciers in Norway, Mike graduated with an MA in 1951.



After graduation, Mike joined Sir William Halcrow and Partners and was put to work on the Shire Valley Project in Nyasaland (now Malawi). Surveys were made for future development of hydropower, water supply, irrigation and drainage (subsequently returning to the UK by motorbike – 9076 miles in four months, half in Africa and half in Europe!).

The next assignment with Halcrows was back to Africa, to Accra in the Gold Coast (now Ghana) to work on aspects of the Volta River Project. Mike remembered that his new c t. Mike's work, managing and expanding the hydrometric network, took him all over the country in a trusty Landrover with a team of three.

Mike left Accra in August 1955 and returned home to be one of the four students taking part in the inaugural 1-year postgraduate course in engineering hydrology under Professor Peter Wolf. He said it gave him an all-round introduction to the whole subject. The extra training helped him secure his next job which was with Binnie, Deacon and Courley who were about to start a Hydrological Survey of Iraq. His main task was to implement a snow survey and forecasting service to inform the operation of dams and other river works on the Tigris river. Choosing accessible sites and training local observers to record depths and water equivalents was a challenging task but 23 observation sites, over a 200-mile mountain arc at elevations up to 8600 ft., were in use by Spring 1958. Mike said he greatly enjoyed working with the local Kurdish workforce despite, on one occasion, receiving a death threat for reasons which he never understood!

Following on from the snow work, Mike found himself appointed as Binnie's flood hydrologist for the Mangla Dam in Pakistan. This was new territory for him, as indeed it would have been for any UK hydrologist (of which there were still rather few). It was very frustrating at the start: local engineers and meteorologists had not worked together before and acquiring post-partition (ie post-1947) rainfall data from the Indian headwaters of the catchment proved impossible. There was one incident in August 1958 which might amuse hydrometry staff in the Environment Agency: hearing that there was large flood happening at Mangla, Mike went to the bazaar (in Lahore) and bought a dozen hurricane lamps, one-gallon oil tins, timber and rope. He then sped the 100 miles to Mangla where he marshalled assistants to make small rafts, each to carry a lamp. At midnight, they launched the rafts and timed them over a straight mile. The measured velocities were several times higher than any made previously! The estimated peak flow of approx 15000 cumecs was about half that of the previous 1929 maximum. Studies of probable maximum precipitation over the catchment led to a spillway design flood peak of 73600 cumecs and Mike presented a paper describing the studies (with G M Binnie) to the Institution of Civil Engineers in 1965.

The early sixties saw the introduction of the Water Res ources Bill which led, via the 1963 Act, to the establishment of the Water Resources Board and, in England and Wales, a number of River Authorities. The proposed number was initially 29 but Mike, working as an advisor, recommended ten; 12 was the final choice. Mike was in the Public Gallery on 20 December 1962 when the need for hydrologists was raised. They were described as 'Avis Rara' (rare birds) - which pleased him immensely.

Hydrological work at Binnies continued to grow – by 1969 there were 12 and, later, over 20. Mike was in overall charge but concentrated on overseas work, leaving his colleague Frank Law to lead studies in the UK.

In 1965, the Institution of Civil Engineers set up a committee to review the whole question of floods in the UK and Mike was appointed Technical Secretary. The committee's report, drafted by him, led to the creation of the UK Flood Studies Team which was set up, at the Institute of Hydrology (part of the Natural Environment Research Council), in 1969. Mike became a consultant to the team. The outcome of their work, the Flood Studies Report, was published in 1975 and became a landmark publication in UK hydrology.

Whilst in Iran, in February 1968, Mike met Marion Jordan, a secretary at the British Embassy. They spent time together on trips there and in Italy before becoming engaged at the end of the year. They were married on 17th May 1969 in the church besides the Thames at Clifton Hampden. Mike's brother Peter was Best Man as Mike had been for him a few years earlier. Mike and Marion honeymooned in south-west Ireland. Their son, David, was born in December 1972 and daughter, Jenny, in January 1976

In July 1982 there was an Assembly of the International Association of Scientific Hydrology held at Exeter University. One evening, a group of four delegates were talking at the bar and the idea of forming a Hydrological Society was developed. The main forum for debating hydrological topics was, at that time, an 'Informal Discussion Group' of the Institution of Civil Engineers but there was a feeling that an independent Society would be better placed to advance the subject. The next day, about 75 delegates met to approve the idea and Mike was asked to be Chairman of an Initial Planning Group. This led, fifteen months later, to the inaugural meeting of the British Hydrological Society which was held at The Royal Society on 1st November 1983. Mike had earlier been elected as Founder President (a two-year term) which was a source of great pride for him. He was able to prescribe the broad basis of the Society which, he insisted, should cover academic research as well as practical applications. The membership rose steadily over succeeding years to over one thousand. Mike later became its first Honorary Life Member.

Although being 'retained' by Binnies, Mike was an independent consultant from 1969. As described, most of his work was overseas but he was also involved in a number of UK investigations. One which occupied him a great deal up to (and beyond 'retirement'!) was into the consequences of abstraction from chalk catchments. The adverse environmental effect on river flows of increased borehole abstraction has become better appreciated now but, before the 1970s, there was little attention paid to the issue. Mike was pleased to be on the 'right' side of the ongoing debate.

As Mike's primary school report said in the early 1930s, he 'is cheerful company and everyone will miss him terribly when he leaves'. That was equally true 90 years later; he always seemed to be smiling!

The British Hydrological Society owes much to Mike's vision of its structure and aims. We extend our sympathy to Marion, children David and Jenny, to the wider family and to all friends and colleagues with memories of his considerable energy and enthusiasm for his chosen discipline.

Mike Lowing
May 2022

UK Hydrological Bulletin: February 2022– April 2022

The February-April period was notably mild — provisionally the 8th warmest for the UK in the Met Office series from 1884 — with rainfall over the three months very close to the long-term average. Importantly however regional and, particularly, temporal contrasts in rainfall and runoff patterns were very substantial with many rivers registering an exceptional range of flows over the featured period. A cluster of named storms in February brought high winds and heavy precipitation — including substantial snowfall in northern areas. Over the latter half of the month transport disruption was widespread and floodplain inundations were extensive and persistent. Correspondingly, February runoff totals exceeded previous maxima in many catchments and, with a few exceptions, ensured that reservoir stocks were close to capacity by month-end. Thereafter, a decisive synoptic change resulted in sustained and steep river flow recessions in most regions and new minimum flows for March were recorded in a considerable number of index rivers. High pressure continued to dominate weather patterns throughout most of April and, again, seasonally very depressed flows characterised most of the UK by month-end. Despite this, reservoirs stocks in most areas were only modestly below the late-spring average and groundwater levels, though low in the most responsive aquifers, remained within the normal mid-spring range.

A very active Jet Stream fed a rare cluster of three named storms across the UK within the space of a week, making for exceptionally boisterous weather conditions throughout much of February. Wind damage was extensive and rainfall totals were exceptionally high – some areas, mostly in the Midlands and the North, registered more than twice the average monthly rainfall. For the UK as a whole it was, provisionally, the 7th wettest February in the Met Office series from 1862. Flood warnings were particularly extensive during the third week when 72-hour rainfall totals exceeded 100 mm in some areas (e.g. in the Lake District). The Severn basin, Pennine valleys and Northern Ireland were particularly badly impacted but notably high river flows in many parts of the country contributed to exceptional outflows at the national scale. A rare Red Weather Warning was issued on the 18th when high winds and blizzard conditions extended across most of northern Britain as the passage of Storm Franklin triggered around 200 Flood Warnings across England & Wales (a proportion of which were tidal). Exceptional peak flows were recorded in many index rivers including the Severn, Mersey, Derwent, Wharfe and Mourne (Northern Ireland).

Floodplain inundations were both widespread and persistent; surface flooding was also extensive resulting in major transport disruption in many parts of the UK. A beneficial impact of the exceptional precipitation was the boost to reservoir stocks which at month-end stood close to capacity across most of the UK, a few southern reservoirs excepted. Whilst groundwater levels remained appreciably below average across much of the English Lowlands, steep recoveries were recorded in many fast-responding boreholes

– for example in the Chalk of Northern Ireland and the Carboniferous Limestone in Derbyshire where levels at Alstonfield were close to the highest on record for the late winter; this contrasted with below the seasonal average levels across much of the southern Chalk outcrop.

The counterbalancing impact of the relatively dry December and January resulted in near-average winter precipitation for the UK. This is confirmed by Fig. 1 which also indicates an 16% percent increase in UK winter rainfall over the Met. Office's 162-year national series (the likely underestimation of snowfall in much of the early record may imply a slightly more moderate trend).

March was a relatively dry month; the final fortnight being particularly arid. The UK rainfall total was 40% below average with meagre monthly totals in many western areas, parts of East Anglia also. Some moderate flooding occurred, e.g. on the 16th when many Midland and southern rivers were in spate; significant surface flooding also occurred in a number of urban areas. Thereafter, flow patterns across most of the UK were characterised by steep recessions with seasonally depressed runoff at month end. Flows were particularly depressed in northern Scotland where the river Oykel registered its lowest March runoff in a series from 1977. In Northern Ireland flows in the Laggan fell below previous minimum for late March as, in Scotland, did flows in the Forth. Particularly depressed flows also characterised rivers draining from Snowdonia and some Pennine catchments. By contrast, the heavy late-winter recharge ensured that March groundwater levels in most index wells and boreholes remained above average – exceptions included the fast-responding sandstones in South Wales and a number of southern Chalk wells.

April was another exceptional month; it was notably warm and the sunniest for the UK since 1929. It was also dry – registering only around half of the monthly average for the UK as a whole. As significantly, the normal north-west to south-east rainfall gradient across the country was strongly enhanced. A few areas in northern Scotland recorded more than twice the average rainfall whilst very arid conditions characterised much of south-east Britain; some catchments in East Anglia and Kent recording less than 20% of the April average. Correspondingly, river flow

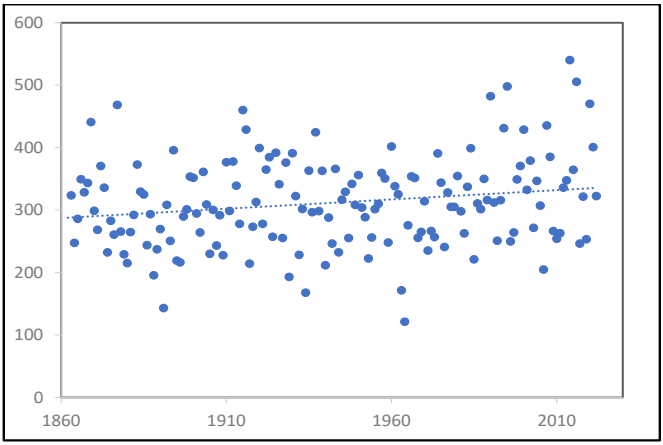


Fig. 1. Winter (Dec-Feb) rainfall for England & Wales (Data source: Met Office)

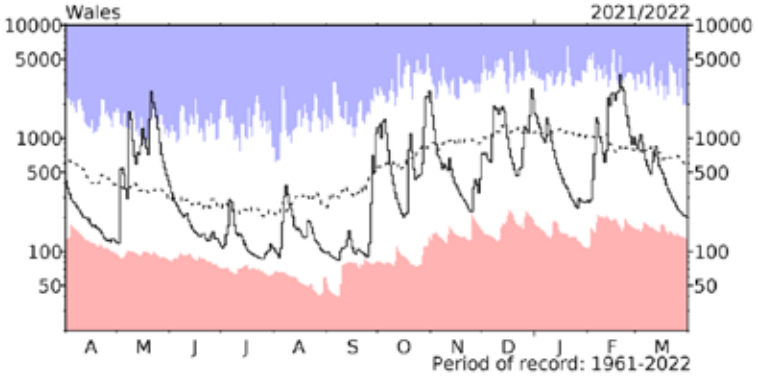


Fig. 2 Daily outflows from Wales (m^3s^{-1}). The blue and pink envelopes are the highest and lowest daily flows on record; the broken trace is the long term daily average (Data source: Natural Resources Wales)

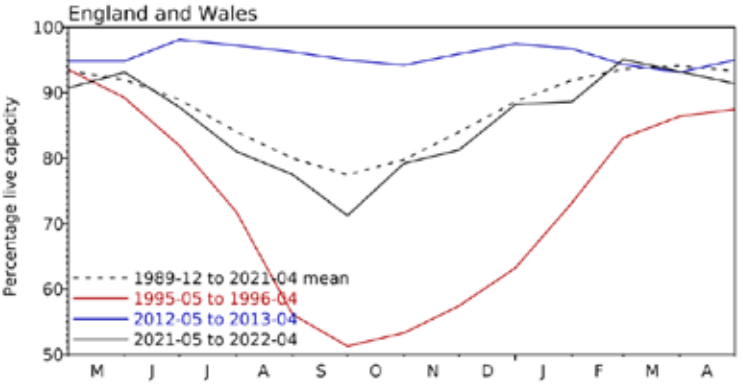


Fig. 3 End-of-month reservoir stocks for England & Wales as a percentage of capacity; the broken trace is the long term average

recessions were steep and protracted particularly over the latter half of the month. Late-April flows fell close to, or below, the lowest for the time of year in many catchments from the Tees to the Exe and overall outflows from Wales were particularly depressed (Fig. 2). Very meagre flows also characterised many urban rivers and streams, particularly in London. By contrast, a substantial proportion of groundwater-fed rivers and streams continued to benefit from the abundant late-winter aquifer recharge and flows generally remained within the normal spring range. Despite appreciable declines through the month, this was true of most reservoir stocks also (Fig.3) However, the limited rainfall and above average April temperatures combined to increase soil moisture deficits substantially. The resulting arid conditions caused problems for farmers and growers especially in the English Lowlands at a critical time in the agricultural calendar.

Terry Marsh
17/05 /22


BHS2022
12–13 September 22
14 September : field day in Cumbria
Conference website:
www.lancaster.ac.uk/bhs2022
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