British Hydrological Society

Sixteenth National Hydrology Symposium

University of Leeds · 2–4 September 2026

FINAL BOOK OF ABSTRACTS

Section 1 Presentations · 72 talks across 12 sessions

Section 2 Posters · 55 posters

Section 1: Presentations

Listed by session, in programme order. Each entry shows the final title, authors, and abstract.

Session 1 Hydrometry, sensors & the FDRI

PRESENTATION 39

Floods and Droughts Research Infrastructure: nationally representative observatories to better understand and manage risk from hydrological extremes

FDRI Catchment Champions (Kieran Khamis and the FDRI team)

The 2017 UK Climate Change Risk Assessment highlighted floods and droughts as two of the most significant threats facing the UK. The Floods and Droughts Research Infrastructure (FDRI) project is a £38M NERC investment to better understand and manage risk from hydrological extremes. The project includes the installation of fixed equipment in three nationally representative observatories in the Chess, Upper Severn, and Upper Tweed, as well as mobile equipment that can be deployed nationally. The project aims to create a near real-time whole system monitoring platform for the UK hydrological community to use and build on to better understand water input, movement and storage across the hydrological cycle during extremes. We will present the key science priorities for each catchment and examples of the proposed instrumentation network. We welcome feedback and engagement as part of the continued co-design of the infrastructure with the hydrological community. More detailed information related to each catchment is presented in three separate posters.

PRESENTATION 130

Enhancing Access to UK Hydrological Data: The FDRI Digital Platform

Matthew Fry

UKRI is investing £38 million in the Floods and Droughts Research Infrastructure (FDRI) to strengthen hydrological research capability and support improved management of future flood and drought risk. FDRI will provide a nationally significant platform combining field-based observation, digital infrastructure, and community engagement to benefit researchers, consultancies, and regulators alike.

Field activities will focus on three digitally enhanced UK sub-catchments, delivering high-resolution, end-to-end monitoring of the water cycle alongside accessible sites for testing new methods, sensors, and models. These physical assets are complemented by a digital platform designed to improve discovery, access, and reuse of hydrological data across the UK.

The first iteration of the digital platform, to be launched in September 2026, will provide a user-friendly entry point to FDRI resources, a searchable catalogue of FDRI and wider UK hydrological datasets, interactive maps of monitored catchments, and tools for visualising real-time and historic time-series data. Services will also be provided to support access to large gridded datasets and national LiDAR data, enabling efficient analysis within research, consultancy, and regulatory workflows.

This presentation will demonstrate the initial tools and outline how the BHS community can help shape FDRI's ongoing development, ensuring it delivers lasting value for science, practice, and policy.

PRESENTATION 61

(FDRI) Enabling Participatory Hydrology through Innovation and Capacity Building

Luke Tumelty, Wouter Buytaert, Thomas Rowan, Alejandro Dussailant, Louise Ander, Ali Rudd

Hydrological monitoring is increasingly expected to be more innovative, inclusive, and responsive to rapid environmental change and advances in low-cost, open-source hardware and digital tools are expanding what is possible beyond traditional, centrally managed monitoring networks. This presentation explores how these developments can be brought together through participatory approaches drawing on recent work within the Floods and Droughts Research Infrastructure (FDRI).

FDRI is establishing a national research infrastructure to support long-term, interdisciplinary hydrological research across multiple UK catchments. As part of this effort, we convened a hands-on workshop involving researchers, public sector practitioners, technology developers, and community monitoring groups to explore the role of open

and low-cost hardware in environmental sensing. Practical considerations such as deployment constraints, maintenance, data stewardship, trust, and the institutional and social contexts in which monitoring takes place.

This presentation synthesises key insights from the workshop, highlighting how social innovation can complement the technological to build resilience, and long-term sustainability of monitoring efforts. We reflect on lessons for research design and infrastructure development and discuss how open hardware can act as a bridge between professional hydrology and community-led observation.

PRESENTATION 117

Measuring floodplain flows with consumer electronics and constellations of satellites!

Nick Everard (UKCEH), Andrew Black (Dundee), Alessandro Dussaillant (UKCEH)

The accurate measurement of river discharge during major floods is of critical importance for flood modelling, flood defence design, climate change projections and for flood incident management. Until recently however, making measurements of water flowing on a floodplain was a difficult and potentially hazardous task for hydrometry practitioners, with multiple challenges relating to timing, measurement technology, safety and available people resources.

Now however, thanks to rapid advances in technologies, most of which were never intended for application in hydrology, the prospects for making valuable measurements of floodplain flows are improving dramatically.

Technologies ranging from low-cost wildlife cameras to aerial camera-drones and even high-resolution satellites offer unprecedented opportunities to greatly improve our understanding of the extent, duration and magnitude of floodplain flows.

A February 2026 thematic meeting, co-hosted by the British Hydrological Society and the UKRI Floods & Droughts Research Infrastructure programme, concluded that action must be taken to improve the observation of floodplain flows. This presentation will highlight current developments and future prospects for measuring floodplain flows and will seek to inspire conference attendees to engage with the floodplain flows working group that arose from the February 2026 meeting.

PRESENTATION 50

Quantifying and Communicating Hydrometric Uncertainty

Adam Griffin, Sara Alexander, Gianni Vesuviano, Robert Moore, Nick Everard, Steve Turner, Carl Townley

Hydrometric uncertainty – how we quantify the variability and unknowns in level, flow and precipitation measurements – underpins and propagates through all hydrological analysis. It impacts uncertainty in everything from water resource management through to flood hazard mitigation. Therefore, it is key that people who collect, analyse and use hydrometric data can understand these uncertainties. As part of the Flood Hydrology Improvement Programme, UKCEH, BioSS and the Environment Agency are building on the findings and recommendations from Phase 1 of this uncertainty project. They are developing ways of quantifying and communicating hydrometric uncertainty to hydrometrists, hydrologists, technical- and non-technical users across engineering and decision-making. This has involved assessing current practices and what uncertainty data is available, and exploring what could be calculated and made available in the future.

Project progress will be reported on and include some preliminary examples of new uncertainty information pages intended to elicit feedback prior to project closure. The focus of the current project is a set of proof-of-concept uncertainty metrics and visualisations for a set of case studies, aided through cooperation with the National River Flow Archive and the Flood and Drought Research Infrastructure project.

Reporting for this work will be published in 2027, and there will be an end-of-project workshop in December 2026 to disseminate the findings further.

PRESENTATION 139

An unexpected downpour in rainfall observers

Antonia MacDonald

In the last few decades, there has been an increasing decline in the size of the UK rainfall network. One key issue contributing to this is the difficulties in maintaining current and recruiting new rainfall observers. The Volunteer Rainfall Observers' Network is a long-standing UK citizen science programme in which volunteers manually measure

rainfall each day. It is jointly run by the Environment Agency and the Met Office and forms a crucial part of the UK's national rainfall record. Last October 2025, the Environment Agency received a small flurry of emails of interested potential volunteers, following an BBC Inside Science Radio 4 interview by Met Office volunteer Stephen Burt and climate scientist Professor Ed Hawkins.

This presentation would examine the evolving role of citizen science within rainfall observation. Specifically we will cover trends in network coverage, the balance between manual (volunteer-read) and automatic gauges, and how we can address barriers that may limit the uptake of new observers. Alongside this technical perspective, we consider how communication, media, and storytelling can positively influence public engagement with hydrology and data collection.

PRESENTATION 80

Hydrometric challenges on the ground

Joe Davies, Joe Pearce

Climate change is increasingly affecting the UK through altered weather patterns, more frequent extreme rainfall, and growing pressure on water resources. As a result, the study and interpretation of hydrological data have never been more important. Such information now underpins flood forecasting, the resilience of drinking water supplies, and the protection of vulnerable ecosystems. The insights produced by hydrologists directly influence community wellbeing, infrastructure performance, and environmental health.

Demand for accurate and timely hydrological data continues to rise, with government bodies, consultants, researchers, and private sector organisations depending on these datasets for planning, policy, and operational decisions. Expectations for the quantity and quality of hydrometric information are increasing, prompting significant changes in how data is collected and analysed.

This presentation explores the day to day challenges of a Hydrometry team while trying to meet the changing demands for hydrological data. It will describe some of the developments in hydrometry and telemetry within the Environment Agency, new technologies and the challenges of managing legacy data collection networks. It also explores how climate driven hydrological change is reshaping monitoring priorities and operational pressures.

Session 2 Natural flood management — evidence & practice

PRESENTATION 76

Natural Flood Management: Bridging Policy, Research, and Operational Practice

Dr Ann Kretzschmar

Alan Lovell (EA Chair) said: "It's exciting to see such appetite for Natural Flood Management (NFM), recognising its value in providing not only benefits against flood risk but also wider support for nature recovery."

NFM is increasingly being discussed as part of UK flood-risk policy, but its integration into operational practice is limited. Nature based solutions are promoted as part of climate resilient catchment management, however many barriers restrict its implementation. Research has significantly increased understanding, but evidence gaps remain at larger scales, under extreme events and in systems where groundwater or tides dominate. By combining a solid understanding of catchment processes with practical, data-led modelling, whole catchment benefits can be estimated without needing complex, fully distributed models. NFM must be treated like a key piece of infrastructure with interventions chosen based on a clear understanding of local processes with the co-operation of local communities, then designed with straightforward, consistent guidance. Monitoring and modelling is a must but requires simple, robust methods. NFM should be fully built into decision-making and appraisal frameworks.

This presentation explores NFM from an operational perspective—how it functions in real catchments, how to make it work in practice and what is required to embed it as a routine operational tool. By strengthening the links between policy, research and operational needs, NFM can move from being a developing idea to a reliable, operational part of UK flood risk management.

PRESENTATION 26

Natural flood management optimisation for property damage reduction using a fully distributed hydrological model

Asid Ur Rehman, Elizabeth Lewis, Ben Smith, Steve Birkinshaw

Natural Flood Management (NFM) can viably complement engineered flood defences in reducing flood risk. Although a growing body of literature has begun to quantify how interventions such as runoff attenuation features (RAFs), woodland creation, and soil management influence catchment response, evidence remains fragmented across spatial scales and modelling approaches, and translating hydrological benefits into cost-effective risk reduction portfolios remains limited. Moreover, configuring these decentralised measures requires a systematic framework to desynchronise peak flows and effectively reduce flood risk. This study develops such a framework that represents NFM within a physically based, fully distributed SHETRAN model and optimises the location and size of interventions across the catchment using a multi-objective optimisation approach. The framework aims to minimise the NFM area while maximising reductions in property damage. To reduce computational demand, a representative one-week event is used to estimate changes in return periods following NFM implementation, and these changes are then used to estimate damage reduction. Results indicate that upstream interventions are the most cost-effective, with soil improvement providing the greatest reduction in damage costs, followed by woodland creation, while RAFs show limited impact on risk reduction. The optimisation framework proves essential for identifying cost-effective combinations of NFM measures. This work provides a foundation for more efficient, evidence-based allocation of flood risk management investments.

PRESENTATION 81

Hydrological Assessment of Multiple Natural Flood Management Interventions in Rapid-Response Catchments

Mehdi Bagheri-Gavkosh, Alan Puttock, Diego Panici, Gale Alexander, Tom Dauben, Richard E. Brazier

Natural Flood Management (NFM) has emerged as a key Nature-based Solution (NbS) for reducing flood risk. While previous studies have demonstrated the effectiveness of individual NFM measures, there remains limited evidence on the combined performance of different interventions across multiple rapid-response catchments. This study addresses this gap by quantifying the integrated hydrological and hydraulic impacts of NFM strategies across five sites in Devon, UK. A high-frequency hydrological monitoring network was established across study catchments, applying Before–After Control–Impact approaches over 15–36 months. Data were collected at 5–15-minute intervals, enabling the analysis of 662 high-flow events. Results indicate that NFM interventions reduce peak flows by 30–60% and increase lag times by 7–50% (mean 30 min), demonstrating substantial attenuation of flood responses. Seasonal performance varied with antecedent moisture conditions and hydraulic activation thresholds, with storage-based NFM measures showing more consistent attenuation under drier conditions, while leaky barrier interventions were more event-dependent. Peak-flow reductions were evident across exceedance probabilities of 20–80%, although attenuation declined slightly for larger, rarer events. These results provide the evidence base for multiple NFM strategies and show that implementation in fast-responding catchments may provide a minimum of 30% flood peak reduction and 7% of lag time increase, which will be instrumental in increasing the resilience of rural communities affected by flooding.

PRESENTATION 88

Assessing the benefits of NFM interventions at scale using distributed hydrology and physical indexing

Paul Smith, Iain Craigen, Barry Hankin and Eleanor Pearson. JBA Consulting.

As NFM interventions take an increasingly prominent role in flood risk management there is a growing need to assess interactions between NFM schemes and the potential (dis)benefits across larger catchments. This presentation draws upon work in larger catchments in the UK and abroad to show how this can be achieved. Using a semi-distributed hydrological model (dynatop), the changes in peak flow caused by combinations of NFM interventions such as leaky barriers, woodland planting and infiltration improvements, at sites impacted by flooding are assessed. By indexing the peak flow to the damages caused within the areas impacted we demonstrate how reductions in losses can be quickly computed and visualised. We discuss the challenges and limitations of the approach and highlight where further work may support improved decision making.

PRESENTATION 68

Monitoring for NFM: A Yorkshire Case Study

Rebecca Dunstan (Arup), Louise Parry (Arup), Sophie Vanicat (EA)

Despite increased emphasis on nature-based solutions such as Natural Flood Management (NFM) measures and improved land management practices (e.g. aeration, reduced grazing, hedgerow planting) to tackle flood risk and improve habitats and biodiversity, there is limited evidence from monitoring to verify their impact at local and catchment scales. This cross-disciplinary Environment Agency (EA) research project seeks to provide a much needed resource of information for other industry projects to understand and develop options to monitor, model and quantify the effectiveness of NFM in practice.

The Otterburn catchment is an 18 km2 upland tributary to the River Aire which has seen various NFM and land management interventions carried out by the Yorkshire Wildlife Trust and local landowners over the last decade. Arup and the EA have monitored the catchment between October 2024 and May 2026 to attempt to understand the impact of the NFM on river flow and the environment. Measurements collected include continuous observations of river level, flow and water quality, soil moisture and rainfall, and spot samples of soil parameters such as soil carbon and hydraulic conductivity collected by the University of Leeds. We have used the data collected to model the catchment response to rainfall, and assess the variation in response in relation to NFM and land management. The data collected and site visits by BNG and aquatic ecology specialists have allowed us to assess the wider benefits of NFM and limitations of current scoring metrics. We will discuss the findings and lessons learned.

PRESENTATION 86

Beaver Reintroduction: Can We Expect Changes to Peak Flows, and What Drives Them?

Ben Jackson, Alan Puttock, Diego Panici, and Richard Brazier

The Eurasian beaver has been reintroduced to Great Britain after ~400 years. As ecosystem engineers, beavers build dams, excavate channels, and maintain wetlands, potentially delivering ecosystem services such as flow attenuation. To guide future releases, evidence is needed to quantify these effects and clarify the mechanisms driving them, so we can identify conditions that maximise their hydrological benefits.

We applied the 2D hydraulic model HEC RAS to sites across England selected for their potential to support dam building. Dams were represented as digitised weirs intersected by culverts to allow leakage and overtopping. Dam locations were chosen to meet minimum water depth requirements for beaver habitat. We ran 2D simulations that systematically varied dam geometry and permeability (“leakiness”) at each site. Each configuration was evaluated under storms of varying magnitude across 16 sites across England.

Peak flow attenuation occurs via two mechanisms: (a) in channel detention behind the dam, which delays and reduces the hydrograph peak, but only when the dam is not overtopped or overtopping is delayed until after the flood wave arrival; and (b) overbank routing onto the floodplain. The magnitude of floodplain driven attenuation scales with the diverted volume, the number and dispersion of flow paths, and overland losses. For both mechanisms, topography with respect to the orientation and height of the dam exerts a strong control on peak flow attenuation.

Session 3 Community, policy & the future of hydrology

PRESENTATION 38

Delivering the UK Flood Hydrology Roadmap

Gary Quinn - UK Flood Hydrology Roadmap Chair - DfI Northern Ireland

The UK Flood Hydrology Roadmap sets out a shared 25-year vision to strengthen flood hydrology science and its application in managing flood risk across the UK. Developed by and for the flood hydrology community, the Roadmap spans all sources of inland flooding and the full pathway from research, data and methods development through to operational guidance and decision-making. Its core purpose is to improve the translation of science into practice by aligning research activity with operational need and long-term policy objectives.

This joint presentation from the Roadmap Governance Board and Specialist Technical Advisory Groups (STAGs) will provide an update on delivery, with particular emphasis on progress achieved over the past year. It will highlight how governance and advisory structures are enabling effective science-to-practice pathways. The promotion of

Roadmap badges during this presentation and symposium will provide a practical mechanism to acknowledge researchers and practitioners working in specific areas of flood hydrology, while clearly linking their outputs to the shared objectives of the Roadmap.

The presentation will reflect on the role of oversight in maintaining strategic coherence, managing dependencies and supporting collaboration across research projects and UK administrations, and will outline how the Roadmap continues to provide a stable but adaptive framework for strengthening flood resilience in a changing climate.

PRESENTATION 127

Hydrology skills for a changing world: Progress against Action W5 of the UK Flood Hydrology Roadmap

Chris Skinner, Linda Speight, Clare Waller, and the Scientific and Technical Advisory Group (STAG) to the UK Flood Hydrology Roadmap (UKFHR)

The users of hydrology work across a wide range of sectors contributing valuable cross-cutting knowledge and skills. As hydrological pressures in a changing world increase, their expertise must also increase and diversify. The UK's Flood Hydrology Roadmap highlights the need to adapt and strengthen the hydrology workforce to meet its vision and objectives. In this presentation we reflect on the progress made to date against Action W5 of the Roadmap – Build hydrological skill, esteem and value – and implications for the future of hydrology education and training.

Central to delivering Action W5 have been the findings of the UK's first Hydrology Skills and Satisfaction Survey, which was conducted in 2023 to establish a baseline from which to measure progress. The 'Skills Survey' revealed a historical 'geographical turn' in hydrology education, with a workforce transitioning from predominantly engineering backgrounds to more geographical or environmental training as demands changed. With the emergence of machine learning methods, hydrology is potentially on the cusp of a 'data-driven turn' where users of hydrology need to harness new technical skills to further develop hydrological knowledge.

Adapting to the data-driven turn is a major challenge for the hydrological community. A follow-up to the Skills Survey conducted in 2025 revealed critical skills gaps for the required technical skills, as well as strong desire for training. We will conclude by presenting case studies that show positive progress to addressing these gaps.

PRESENTATION 110

Joining up Hydrology at the Environment Agency

Antoine Lebrun

Hydrology at the Environment Agency (EA) underpins flood risk management, water resources regulation, drought response, and environmental protection across England. In this presentation we will narrate and share the life of hydrometric and hydrological data within the EA, from observation to operational use and research application.

In this presentation we will describe how hydrometric data are captured through national monitoring networks by hydrometry teams, quality assured and managed to provide a trusted evidence base and then used by hydrologists working across high flow and low flow disciplines. These data support real time operational decision-making during floods and droughts, regulatory assessments, forecasting and modelling, and longer-term analysis of climate and land use change. We also show how the same datasets are reused in research, method development, and national improvement programmes, creating feedback loops that strengthen monitoring strategies, modelling approaches, and uncertainty understanding.

By following the data through its full life cycle, our presentation will highlight the interdependencies between hydrometry, operational hydrology, and research, and the roles played by national teams, local area teams, and specialist programmes. This integrated view reflects the EA's move towards a more connected hydrology service, better equipped to respond to a changing climate and growing pressures on the water environment.

PRESENTATION 40

West Yorkshire Flood Innovation Programme: An innovative collaboration for improved flood resilience

Mark Wilkinson

The West Yorkshire Flood Innovation Programme (WYFLIP) is a four-year collaborative partnership developing evidence for innovative approaches to managing flood risk at a catchment scale. It brings together the five Lead

Local Flood Authorities in West Yorkshire, the Environment Agency, West Yorkshire Combined Authority, Yorkshire Water and the University of Leeds' Integrated Catchment Solutions Programme, enabling collaboration across boundaries and between organisations who do not normally work together. Wider stakeholders bring expertise in community development, finance, education, technology and health. Learning from the programme is shared across organisations regionally, nationally and internationally.

WYFLIPs flexible approach enables partners to respond to emerging issues, undertake innovative research and apply the latest scientific evidence to develop practical solutions. The programme has five themes, each led by a local authority: integrated water management, nature based solutions, property flood resilience, community and voluntary sector partnerships and enhanced flood warning systems.

WYFLIP has secured over £1.2million of investment, with more bids in development. Projects include creating a blue green infrastructure training programme, piloting real time sensors for surface water flooding and improving mental health support in flood affected communities.

This presentation will outline how the WYFLIP model can be applied to hydrological challenges at different scales, with diverse stakeholders. We will share successes, challenges and future plans.

PRESENTATION 35

How does flooding affect the mental health of communities?

Jason Hanks

Climate-related disasters have profound impacts on mental health. People who experience flooding in their homes are 6–9 times more likely to develop mental health conditions than those unaffected. As climate change increases the frequency and severity of flooding, authorities face growing challenges to ensure communities can access effective mental health support to strengthen resilience and improve preparedness.

Funded by the Yorkshire Regional Flood and Coastal Committee, the West Yorkshire Flood Innovation Programme is working to understand the mental health impacts of flooding and to work with first responders and communities to enhance resilience. Led by Kirklees Council the project includes psychological first aid training for staff supporting flood-prone communities; awareness campaigns promoting support such as green social prescribing, wellbeing packs and community events; an online survey of Yorkshire residents affected by or at risk of flooding; in-depth interviews with flood victims; and workshops with communities to co-design resources and preparedness tools.

Early findings reveal that people whose properties have been flooded report depression, anxiety, persistent worry and PTSD-related symptoms such as intrusive memories, distress and difficulty concentrating. Flooding is often experienced as a cycle of threat, with heavy rain triggering heightened fear and anticipation.

Our presentation will demonstrate how our findings are informing practical, community-focused tools and policy recommendations to improve mental health resilience and flood preparedness.

Session 4 International & global hydrology

PRESENTATION 92

From source to sea, to the IPCC: the incredible journey of UK rivers in helping to understand global hydrological variability

Jamie Hannaford, Steve Turner, Wilson Chan, Lucy Barker, Sayali Pawar, Gayatri Suman, Rachael Armitage, Helen Davies, Adam Griffin, Amit Kumar, Harry Dixon. And the global ROBIN Network.

UK river flow data has huge operational and scientific value, underpinning domestic water management and research across a whole range of applications. It is perhaps less widely known quite how far some river flow data travels: small catchments in remote locations can find their way into initiatives that resonate globally. We will tell the story of this journey, focusing on how the UK is leading efforts to understand global hydrological change through ROBIN (Reference Observatory of Basins for INternational climate detection). With our Benchmark Network, established 2002, the UK was an early adopter of the idea of 'reference' hydrometric networks (RHNs) designated to allow climate signals to be discerned from human influences – reservoirs, abstractions and so on. Through ROBIN we are now connecting RHNs in other countries and stimulating development where they are currently absent. ROBIN includes >70 partners from >40 countries and has delivered an open dataset (over 3000 stations, including 120 from the UK) and code libraries to facilitate data sharing and build capacity. We will present examples of how

the scientific community is analysing ROBIN to shed light on global trends in droughts and floods, demonstrating how ROBIN will meet its stated aim of enabling more confident IPCC assessments of hydrological change. In this way, the local- to national-scale river flow monitoring and archiving efforts undertaken by many a BHS member are contributing towards wider efforts to understand the world's water crises and, ultimately, underpin efforts of humanity to respond in turn.

PRESENTATION 7

Urban Flood Hydrodynamics and Sanitation Infrastructure Exposure During the 2024 El Niño Event in Kibera, Nairobi: A Socio-Technical Analysis

James Wallace, Barbara Evans, John Gathenya, Samuel Mureithi Kioni, Pascal Kipkemboi, Joe Mulligan, Mark A. Trigg, Amos Wandera, Christine Wandera, Mathews Wakhungu

This study examines urban flood hazard and sanitation system exposure in an informal settlement, Kibera, Nairobi, during the 2024 El Niño event. Informal settlements present unique challenges for flood modelling: dense buildings, blocked drains, and small-scale modifications to surface flow are rarely captured in standard datasets or DEMs.

We used a two-dimensional HEC-RAS model to simulate flood depth and velocity from rainfall data, satellite imagery, site surveys, and available infrastructure information. However, DEMs alone miss critical local features such as waste-blocked drains, informal drainage systems, and narrow flow paths. To capture these, six participatory mapping focus groups with community members recorded observed flood extents, depth variations, hydraulic restrictions, as well as the impacts on sanitation systems.

The focus groups revealed localised flooding patterns and hydraulic restrictions that the model alone could not resolve, showing where sanitation systems were most exposed and why some areas flooded unexpectedly. Results highlight the importance of informal drainage and micro-topography in shaping flood behaviour.

By combining event-based hydrodynamic modelling with local spatial knowledge, this study provides a richer understanding of flood risk in data-constrained urban environments and demonstrates how participatory methods can reveal micro-scale vulnerabilities that conventional modelling overlooks. These insights will become increasingly important as extreme rainfall events become more frequent, more intense, and more unpredictable.

PRESENTATION 19

Hydrology for dam safety assessments in Kazakhstan

Duncan Faulkner, Rhiannon Bryan

Northern Kazakhstan is arid, with a hydrological regime dominated by snowmelt. The primary predictor of peak flow during the spring flood is not rainfall, snow depth or melt rate. Instead, it is the amount of precipitation that fell during the previous autumn. For assessing the safety of a pair of Soviet-era dams in cascade, design floods were estimated using a combination of catchment modelling and statistical analysis techniques. The work highlights the importance of process understanding, and the opportunities for combining local and global hydrological datasets.

PRESENTATION 5

Century-old hydrometry meets modern 2D hydraulic modelling on the Congo River

Mark A. Trigg, Raphael M. Tshimanga, Génie Lutonadio

The lower Congo River contains some of the most hydraulically intense conditions of any river on Earth. The Cauldron of Hell, a deeply incised bedrock reach approximately 3 km downstream of Matadi, DRC, carries peak discharges exceeding 60,000 m^3/s through a channel constricting to around 450 m, generating surface currents in excess of 10 knots. This presents a rare and demanding test case for 2D shallow water equation modelling.

A 2D depth-averaged model was constructed in HEC-RAS v6.6, using historical bathymetric data and flow inputs derived from the Kinshasa gauge. The central question was whether century-old field measurements could provide meaningful modern validation. Four independent historical current observations spanning 1915 to 2022, across a discharge range of approximately 35,000 to 70,000 m^3/s, were used to test the model. Overall RMSE against reported surface currents is 0.60 knots across a 5 to 13 knot observed range.

The 1915 survey of Devroey (1941) proved particularly compelling. Flow structures modelled for 2022, including the central jet, flanking recirculation zones, and shear layers, are documented independently in that survey, 107 years

and approximately 40,000 m³/s of discharge apart. Historical hydrometry, when critically evaluated, retains quantitative value far beyond its original purpose.

Session 5 Machine learning & AI in hydrology

PRESENTATION 9

Ever Deeper Learning and the Great Hysteresis Challenge

Keith Beven

Hydrology, as one of the inexact sciences, has a fundamental problem of epistemic uncertainty in respect of both data and process representations. Deep Learning / Machine Learning methods have been claiming to overcome some of that problem by demonstrating improved prediction performance across a wide range of large sample datasets. If improved prediction is the only aim (for example, for flood forecasting purposes) that is not a problem – at least for predictions within the range of the training data. It is clear that pattern recognition in historical time series without any physical constraints can compensate for any consistent epistemic errors in the data, even if a significant tail of catchments for which predictions are poor remain. If improved understanding of hydrological systems with a view to prediction of future change is the aim, then such methods have so far been a dead end. To improve this situation two core issues must be addressed: the first is the identification of epistemic errors in the available data (such as events with apparent runoff coefficients > 1); the second is the identification of improved process representations despite the errors in the data. This second implies a need for a decomposition of epistemic errors and will be expounded here as the Great Hysteresis Challenge for the wider hydrological modelling community.

PRESENTATION 17

Digitally Intelligent Catchments: Are They Needed?

Nick A Chappell

In the emerging era of artificial intelligence, the value of further field monitoring and experimentation is increasingly questioned. Were the hydrologists of the last century so comprehensive in their observations that all relevant hydrological phenomena and behaviours are already known? Do we truly possess the knowledge required to encode hydrological processes into models and guide them in identifying dominant modes and credible system responses?

At the same time, there is growing emphasis on ‘nature-based solutions’ to mitigate water pollution and address the escalating impacts of climate change. Yet these interventions are inherently novel and complex in their hydrological responses. Despite this, there remains a surprising reluctance to acknowledge the need for new observations and the data-driven analyses they enable.

This presentation argues that embracing the full potential of digital technology - linking field sensors into integrated networks and combining them with interpretable machine learning - repositions field experimentation and continuous monitoring at the core of future hydrological research. Realising this vision requires sensing networks that match the resolution, speed, accuracy, and integration capabilities of modern cloud-based systems.

The concept of ‘digitally intelligent catchments’ is illustrated through ongoing research funded by UKRI and Defra, including Natural Flood Management programmes and the NERC Flood and Drought Research Infrastructure.

PRESENTATION 147

AI for Good: An AI-based Flood Warning System for Eastbourne

Lisa Chatterjee and Jenny Roberts

As part of the Environment Agency's Flood and Coastal Resilience Innovation Programme (FCRIP), the Blue Heart project is one of twenty-five local area projects which, in total, have been allocated funds of £150 million over a six-year period. One aim of the project is to develop a flood warning system for Eastbourne, covering flooding from surface water, river and tides.

The proposed talk will outline the process that we at JBA Consulting are going through to develop an AI-based flood warning system for Eastbourne. This involves building and training a Machine Learning (ML) model using data from the existing catchment model. The ML model is not a climate model but, instead, it looks for connections between

rainfall/tidal levels and flooding in order to predict flooding from forecast data. The aim is for the ML model to predict flooding from pluvial, fluvial and tidal sources. Such an integrated approach is new and, though the application of AI technologies is rapidly growing, this project will be one of the first to use AI to inform operational flood forecasting.

The talk will also cover the challenges we have faced, such as utilising a complex but limited catchment model for deriving baseline training data and changes in ML model architecture required to reduce 'AI-noise'; as well as the inherent difficulties and compromises made in trying to simulate a very complex environment, all in one model.

PRESENTATION 103

Propagation and Attribution of Climate-Driven Uncertainty in Fluvial Flood Inundation Using Reduced-Order Surrogates

Adil Siripatana, Alison Kay, Adam Griffin, Amy Wilson and Lindsay Beevers. Institute of Infrastructure and Environment, School of Engineering, University of Edinburgh, UK. UK Centre for Ecology & Hydrology, UK. School of Mathematics and Maxwell Institute for Mathematical Sciences, University of Edinburgh, UK.

Understanding how flood hazard uncertainty evolves under climate change remains a key challenge in flood risk assessment. Future inundation projections are characterised by changes in flow magnitude, timing, and hydrograph shape, introducing complexity in how flood responses differ between present-day and future conditions. Quantifying and comparing these uncertainties using high-fidelity hydraulic models is computationally prohibitive due to the large ensembles required. This study proposes a reduced-order uncertainty-aware surrogate modelling framework to enable efficient propagation and direct comparison of uncertainty in fluvial flood inundation between baseline and future scenarios. The approach combines orthogonal decomposition of spatial flood responses with kriging-based surrogates, allowing accurate representation of inundation dynamics while supporting rapid probabilistic analysis. A structured uncertainty propagation strategy is adopted, to explore the impact of climate projection uncertainty on flood inundation over a variety of case studies. This enables systematic comparison of uncertainty sources and their influence on flood extent and depth across future climates. The framework further supports attribution of uncertainty, providing insight into how dominant drivers of flood inundation shift under climate change and enabling scalable, uncertainty-aware prediction.

PRESENTATION 85

Integrated Digital Hydrology for Low Flow Forecasting: Advancing Water Resources Decision Making

Susana Almeida, Charles Malcolm, Lucy Whitelock-Bell, Alemayehu Asfaw, Justin Garratt, Rosalind Kehoe, Paul Clark

The Forecasting Low Flows Project presents a transformative digital approach for anticipating and managing risks associated with reservoir drawdown and low flow conditions across the Severn Trent Water (STW) supply area. The work, delivered in partnership with STW and the Environment Agency, was motivated by increasing pressure on water resources availability under a changing climate, where proactive understanding of drought risk and system vulnerability is essential.

The project integrates advanced hydrological modelling with the STW water resources model deployed within an intuitive Excel based interface, linking automated data acquisition, scripted hydrological workflows in Python/R, and supply system simulations in Aquator. This enables users to assess reservoir and river flow responses under historic, short term forecast, and long term average meteorological scenarios, supporting robust drought management actions. Key innovations include automated rainfall and PET integration, flexible ensemble scenario generation, and customisable visualisation of reservoir storage and low flow trajectories.

The tool provides early warning of emerging low flow and reservoir drawdown risks, allowing optimisation of operations, improved communication with stakeholders, and exploration of "what if" conditions, such as reduced rainfall futures. Its modular, transferable architecture makes it applicable across the UK water sector, demonstrating clear value through cross agency collaboration, operational relevance, and scalable digital design.

PRESENTATION 146

Towards an Improved Drought Status System in England: Integrating Human Expertise and Machine Learning

Srinidhi Jha, Lucy Barker, Kevin Collins, Mason Durant, Chris Counsell, Adriana Calderon, Jamie Hannaford, Stuart Allen

Despite being a stereotypically wet country, the UK has experienced several significant droughts, from the benchmark, 1976 UK drought to the recent 2025 drought. The Environment Agency (EA) has a statutory duty to secure the proper use of water resources in England, including responding to and managing droughts. The EA uses drought status framework outlined in the policy paper 'Drought: How it is managed in England'(EA, 2025) and EA area drought plans. It uses several hydrometeorological indicators and expert judgement to move from 'normal' to prolonged dry weather, drought, severe drought, and recovery. This study reviews the current system through an international literature review, semi-structured key-informant interviews, and the development of a proof-of-concept machine learning model.

Using hydrometeorological data across 14 EA areas for 2017-2025, we analysed indicators including precipitation, soil moisture deficit, river flows, groundwater levels, reservoir storage, water company drought status and insights from key-informant interviews. Supervised machine learning models were used to classify drought stages using indicator-based and additional features. The model was extended to hindcast conditions to 1995, evaluating feature importance, spatiotemporal patterns, and dominant drivers. Results show regional variability in performance but demonstrate that integrating data-driven methods with expert judgement improves consistency and accuracy. Future work aims to enhance forecasting capacity and support long-term planning and drought response.

PRESENTATION 10

Reimagining UK Hydrological Analysis: Using Machine Learning and AI to Develop Community-Driven Hydrology

Chris Cameron-Hann (Aegaea), Clare Winter (Celox Consulting) and Rebecca Thirkell (Aegaea)

UK hydrology relies on a small number of proprietary tools requiring practitioners to use separate applications for FEH statistical analysis, rainfall-runoff modelling and catchment descriptor retrieval. Manual data transfer and reporting make workflows inefficient, error-prone, and create barriers to entry for smaller consultancies and independent practitioners.

We present Hydrometric, an open-source calculation engine and web platform implementing the FEH Statistical Method (2008 & 2025), rainfall-runoff models and climate change allowances. Its engine is published as TypeScript libraries, enabling independent scrutiny of every equation, from QMED estimation through pooling group formation and growth curve fitting.

Hydrometric introduces three innovations:

A decision-tree interface presenting every analytical pathway (alternative QMED estimates, donor combinations, distribution fits) as an auditable record, replacing the traditional single-path workflow.

Rule-based AI assistance giving inline warnings for statistical anomalies (discordancy, heterogeneity, unusual descriptor values) & contextual suggestions, without reliance on LLMs.

A self-learning architecture where anonymised assessment metadata supports regional bias corrections and donor quality maps, creating collective intelligence that improves with use.

We will discuss the challenges of independently reimplementing FEH methods, the verification used to ensure numerical equivalence with existing tools, and how open-source hydrology software can improve transparency, reproducibility and accessibility in UK flood estimation.

This presentation focuses on the principles, architecture and validation of Hydrometric. The accompanying workshop, "Beyond the Black Box: Practical Flood Estimation with Hydrometric", offers a hands-on introduction to the workflows discussed here, from 11:30–13:00 on Day 1.

Session 6 Flood estimation & frequency methods

PRESENTATION 69

Using a peak-over-threshold model to improve FEH statistical flood frequency estimation

Gianni Vesuviano, Adam Griffin, Hadush Meresa

Peak-over-threshold (POT) flow events are those that exceed a given threshold flow. They usually occur several times per year per station, depending on the threshold and varying between stations and years. In contrast, annual maximum (AMAX) flows occur exactly once per year per station. POT hold several advantages over AMAX. Firstly, POT events can convey much more information about flood frequency distributions, particularly for more common events. This is important for applications like bathing water quality or combined sewer overflows, where the events of interest can happen several times per year. Furthermore, all POT flows are significant at the level set by the threshold, while a particularly small AMAX may not convey any useful information about a flood frequency distribution, even though it is used in an AMAX-based analysis. Additionally, not all AMAX are generated by the same mechanisms, but they are all combined and treated equally in AMAX-based methods.

The Flood Estimation Handbook (FEH) statistical method, and its 2008 and 2025 updates, were developed using AMAX flows. Due to the significant manual review of POTs performed annually by the NRFA, plus the recent release of the UKCEH Flood Event Data Suite, the data now exist to take advantage of the benefits offered by POT and produce a POT-based FEH statistical method to the same quality as the existing AMAX-based method. Here, we present recent work in the FEH team to develop a new POT-based flood frequency method for estimating the index flood and growth curve in gauged and ungauged catchments.

PRESENTATION 54

Recalibrating the ReFH2 Rainfall-Runoff Model for Observed Events using the FEDS Dataset

Rishma Chengot, Tracey Haxton

The Revitalised Flood Hydrograph (ReFH2) hydrological model is the national standard event rainfall-runoff model and part of the UK's Flood Estimation Handbook (FEH) methods. This study presents a large-scale re-evaluation of ReFH2.3 using the UKCEH Flood Event Data Suite (FEDS) derived from the UK-Flow15 gauged flow dataset and CEH-GEAR1hr v2 gridded rainfall.

The study uses a subset of 892 catchments within FEDS to model observed events using ReFH2. A key aim is to assess the practicality, consistency, and suitability of available large, automated flood event datasets such as FEDS for use in event-based hydrological modelling, particularly in the context of calibration and benchmarking. Methods to quality control the event datasets were developed, including identifying zero-rainfall, multi-peak, and pseudo-rainfall events. The identification of catchments that may not be suitable for inclusion was also investigated (e.g those with substantial snowmelt events, or significant storage).

A number of modelling scenarios involving the parameterisation of both DAYMOD (used to model antecedent moisture conditions) and ReFH2 were completed. Model performance was evaluated using multiple measures of fit for peak flow, total flow, time to peak differences as well as overall fit. The study highlights the potential for national scale datasets to support large-scale model recalibration whilst emphasising the importance of robust data screening and parameter sensitivity analysis.

PRESENTATION 58

Proposal for a new method to estimate flood frequency in ungauged (UK) catchments

Ross Woods, Roberto Quaglia, Yanchen Zheng, Yiming Yin, Giulia Giani, Dawei Han, Gemma Coxon, Miguel Rico-Ramirez

This presentation will outline a proposal for a new method to estimate flood frequency in ungauged UK catchments, and report on recent progress. The main motivation for the research is that even the very best existing methods for flood estimation in ungauged UK catchments have relatively high uncertainty, with factorial standard error > 1.4, meaning that 95% confidence intervals on flood estimates are +/- factor of 2.

The new method is a derived distribution method, converting the distribution of event rainfalls into a distribution of maximum annual peak flows. The method takes account of within-storm rainfall patterns, seasonality of rainfall, effects of antecedent conditions, and catchment routing effects. As well as peak flows it also produces estimates of runoff volumes; information is available for monthly and annual maxima.

To date, most progress has been made on rainfall characterisation and event runoff coefficients. Current work is focussed on catchment routing, and on estimation of flood peaks from runoff volumes and event timescales; I will focus on recent results using a dimensionless measure of flood hydrograph shape to help estimate flood peaks.

PRESENTATION 15

Adding modelled data to observed data in flood frequency estimation

Adam Griffin, Jamie Hannaford, Gianni Vesuviano

Current UK flood frequency estimation uses near-instantaneous measurements of discharge to estimate flood peak flows. However, many existing hydrological climate model outputs are shared at a daily timestep, typically presenting average daily flow, including some outputs used in existing climate change allowances – multiplicative scaling factors for specified peak flow return levels. This can make estimation of flow return levels out to 2100 difficult to harmonise with existing flood frequency.

From observations, a new dataset and methodology which combines rainfall hyetographs and flow hydrographs is the Flood Event Data Suite (FEDS), over 170 000 events from across Great Britain. This complements the NRFA Peak Flow dataset, and gauged daily flow data, which provide timeseries for over 1600 stations.

This work looks to explore ways to combine these two aspects through two ideas: using hydrograph properties like event volume to model peak flow values from daily values, and using bias correction approaches on daily flow data to specifically calibrate modelled data for flood frequency estimation. To model daily-to-peak comparison, generalised additive models were used to estimate return levels and L-moments using FEDS. For the bias correction, Quantile Delta Mapping, and Equidistant Quantile Mapping are used in stationary and non-stationary approaches on eFLAG modelled data and NRFA daily flow. Model and bias correction performance varied across catchment size and location, but the methods show promise towards a harmonised model-observation flood frequency approach.

PRESENTATION 2

Identifying the seasonal pattern between recession curves observed on an English catchment using the new hydrograph offset method

Nick Mandeville

This presentation describes a new development of the matching strip method used for identifying the master recession curve. Four individual English catchments were investigated, including the experimental catchment established on the River Crimple at Burn Bridge by the University of Leeds in 1972 to conduct water balance studies. The standard form of the matching strip method was first applied to sets of observed recession curves, plotted on the log10 Q v t axes, downloaded from the National River Flow Archive. This initial analysis gave promising matches between curves observed when the catchment was fully wetted up in the middle of winter, but it could not match up these winter curves with those observed in any of the other three seasons, leading to doubts as to whether a single master recession curve actually exists or not. The new hydrograph offset method improves the flexibility of the matching strip method by introducing a vertical offset along the log10 Q axis, in addition to the normal horizontal time alignment, between the two recession curves. This appears to facilitate the matching up of any pair of recession curves observed on an individual catchment regardless of each of their seasons, and years, of occurrence. In the place of a single master recession curve being identified as the final outcome of the matching strip method, a family of parallel recession curves, with different vertical offsets, plotted on the log10 Q v t axes are proposed instead. These are directly equivalent to a family of proportional recession curves plotted on the linear Q v t axes, and examples of the seasonal variation of the Relative Proportion (RP) factor will be provided for each of the four individual catchments.

PRESENTATION 72

Why won't the Environment Agency use my model?

Anthony Hammond, Antonia MacDonald, Clare Waller, Sarah Warren, Sam Clayton

Flood estimation can be carried out using many different rainfall–runoff models and statistical methods, implementations ranging from pen and paper to spreadsheets, coding environments and bespoke software. However, this alone is not enough. For the Environment Agency to use a model operationally, it must be supported by evidence, documentation, testing and governance that show it is robust, auditable and safe to apply in real-world decision-making.

The Flood Hydrology Improvement Programme project 'New methods in operational flood hydrology' investigates how alternative methods and models can be adopted in operational settings, and how barriers to adoption can be reduced. For a method to be used in flood risk regulation, it must be clearly communicated, open and reproducible, and accepted by relevant authorities. Robust quality assurance (QA) is therefore essential.

The open-source UKFE R package was used as a case study. We present the QA completed on its functions, including peer review, benchmarking, unit testing and accessibility testing. All test cases now pass for the 61 functions tested. To address another barrier to the use of open-source tools, we developed user guidance and training materials to support practitioners.

We also considered what is needed to sustain open-source tools. We recommended hosting the package on GitHub to support community development and technical resilience. A key question remains around maintenance and governance: how can tools be supported over time, and could organisations that benefit contribute staff time to sustain them?

Session 7 Rainfall-runoff modelling & model benchmarking

PRESENTATION 83

On the mathematical scaling laws of simple rainfall-runoff models, and why they matter

Fiona Davies (Bath), Rob Lamb (JBA), Paul Smith (JBA), Phil Trinh (Bath)*

Most process-based rainfall-runoff models contain similar features: they take precipitation and potential evapotranspiration as input, model the increase or decrease of fluid in storages, and provide a mechanism for determining runoff. Model complexity is achieved by considering additional temporal scales, additional stores and linking stores to physical concepts such as soil moisture. Parameters are typically assigned acceptable ranges based on physical reasoning and past experience then calibrated by comparing simulations to observed data. In this talk, we consider more fundamental mathematical properties of a series of simple rainfall-runoff models, focusing on the effects and consequences of parameter scaling. Analysis is presented demonstrating how key properties of rainfall-runoff models can be extracted. We discuss how this analysis can shed insight on the calibration of models, particularly in respect to the search, stability, and well-posedness of optimal parameter choices.

PRESENTATION 102

Quantifying the mathematical personality of the Probability Distributed Model

Amy Darroch (Bath), Rob Lamb (JBA), Paul Smith (JBA), Phil Trinh (Bath)

The Probability Distributed Model (PDM) is a conceptual framework used in hydrology to simulate rainfall-runoff. Most crucially, the model considers a catchment area as composed of a probability distribution of soil moisture capacities. Given precipitation and potential evapotranspiration as input, water is re-distributed between the different soil moisture capacity elements, producing both drainage to subsurface stores and fast runoff to surface stores. In this talk, we present a clear overview of the mathematical structure of PDM and discuss how the response of the model scales with the relationship between parameters and forcing data. The calibration process of PDM is examined considering the scaling behaviours intrinsic to the model. More broadly, we discuss the issue of quantifying rainfall-runoff models by scaling behaviours and if this serves as an important proxy for model differentiation.

PRESENTATION 36

The UK Hydro-MIP: A community model intercomparison project for streamflow simulation across GB

Rosanna Lane, Helen Baron and Emma Robinson

Model intercomparison projects (MIPs) bring modelling communities together to compare and evaluate outputs from multiple models within a consistent framework. This can improve understanding of current modelling capabilities, highlight the relative strengths of different model structures and indicate areas where further model development should be targeted. Here, we introduce the UK Hydro-MIP, a community model intercomparison for streamflow simulation across Great Britain. Members of the community were invited to submit modelled daily river flows 628+ British catchments, following an agreed model protocol to ensure consistency in driving data and output

formats. We received over 20 submissions, covering a diverse range of model types including machine learning models, conceptual to physically based hydrological models, and land surface models. The resultant large sample dataset of modelled flows and evaluation metrics will be made openly available.

Here, we present the UK Hydro-MIP dataset and highlight key findings. We evaluate model skill relative to a set of simple lower benchmarks, demonstrating the relative strengths of different modelling approaches and common modelling challenges across Great Britain.

PRESENTATION 112

How innovative use of daily simulation improved flood forecasting: lessons from catchment scale calibration

Ilona Dezelski (MM), David Ocio (MM), Alan Smith (EA)

Flood forecasting is a critical component of flood risk management in the UK, which is being increasingly challenged by a combination of higher intensity rainfall and wetter winters. Providing enough warning time to communities is becoming more and more important alongside the implementation of structural measures and nature-based solutions.

Daily simulation offers a powerful but underused step in developing robust flood forecasting models. Whilst hydrometric and rainfall networks have advanced, accurately characterising catchment hydrology remains the core challenge. Recent updates to the Environment Agency's Real-Time Flood Forecasting Model Development Guidance emphasises the importance of continuous simulation and representing the full range of flows to improve the estimation of soil moisture antecedent conditions, which are key to increase the reliability of flood forecasts.

This presentation focuses on the role of catchment scale daily simulation in supporting the development of robust flood forecasting models. The approach adopts quality-controlled rainfall datasets and facilitates catchment-wide water balance checks, which can uncover hidden inconsistencies in observed data or biases in rating curves. Daily simulation supports the representation of antecedent conditions and medium to low flows, before moving to sub-daily resolution, where the focus is on high flows. This approach is presented for the Ehen catchment in Cumbria, where it identified rainfall inconsistencies, rating uncertainties, and reservoir effects that influenced flood event forecast performance.

PRESENTATION 113

Hydrological model benchmarking- Results of the UKCP18 Intercomparison project

Elizabeth Lewis et al.

In the UK, national climate risk assessments have highlighted increasing risks associated with hydrological extremes. These results have come from multiple individual modelling studies and have not yet been comprehensively compared. In July 2025 we ran a hackathon to begin an intercomparison project bringing together as many UKCP18 forced hydrological model outputs as possible, leading to the most comprehensive national-scale intercomparison to date of future river flow projections for the UK. The results of the project are being used by the Climate Change Committee to support the next UK Climate Change Risk Assessment.

We synthesise and compare outputs from a diverse range of hydrological models (including conceptual, physically based, and ML models) forced using a consistent set of UKCP18 regional climate model simulations spanning 1980–2080. The intercomparison integrates simulations from major modelling frameworks, including G2G, GR6J, SHETRAN and Decipher. We also include results from a Long Short-Term Memory (LSTM) model, implemented using the neural hydrology framework, marking one of the first national-scale UK climate change impact assessments to directly compare deep learning models with traditional hydrological models under identical forcing conditions. Building on other UK model intercomparison and benchmarking studies, this work provides a complementary evaluation of how hydrological model structure influences projected changes in river flows.

PRESENTATION 67

Evaluating how hydrological models are made and how they perform – understanding model strengths and weaknesses for flood risk management

Helen Harfoot, Tom Willis, Donna Wilson, Sara Alexander, Owain Sheppard, Becky Wilson, Alayne Finlay, Stephen Neill, Aidan Hanna

To open up the way we model flood events across the UK, the Environment Agency, Scottish Environment Protection Agency, Natural Resources Wales and Department for Infrastructure have collaborated to develop a model intercomparison framework. Consisting of two main components; model intercomparison tests reflecting specific operational applications and a scientific model description, the outcomes of the framework will be made freely available to benefit anyone looking to undertake flood risk modelling in the UK.

It is anticipated that the limited model intercomparison tests available at launch, will gradually be supplemented to reflect the full range of operational applications. Model performance will be captured alongside the scientific model description which will contain detailed and consistently presented information on model setup, assumptions, limitations and useability of software.

As the technical assurers of UK flood risk modelling, the EA, NRW, SEPA and DfI will review this evidence to inform guidance on hydrological model selection for flood risk studies from 2027, with the broader aim of improving flood risk understanding across the UK.

Session 8 Climate change & hydrological extremes — droughts

PRESENTATION 70

1976 drought storylines for water resources planning

Anna Murgatroyd, Ben Smith, Hayley Fowler, Wilson Chan, Ed Hawkins

As parts of England face increasing water stress, the widening gap between rising demand and diminishing supply often presents a critical challenge for climate resilience. While statutory mandates require planning for extreme 1-in-500-year events, traditional top-down stochastic modelling often fails to capture non-stationary risks or the nuances of rare extremes within limited hydro-climatic records. This research addresses these limitations by implementing an innovative "bottom-up" climate storylines approach using an integrated climate-hydrology-water resources modelling framework. The study evaluates how a 1976 style drought event would impact contemporary infrastructure, water demand, and regulatory frameworks. The analysis quantifies national and regional supply-demand balances, tracking key metrics such as reservoir drawdown and recovery phases to identify system vulnerabilities. By synthesising historical qualitative data with quantitative simulations of 2025 conditions, the study evaluates the efficacy of modern operational rules and demand-saving measures throughout the drought's full life cycle. Timed with the 50th anniversary of the 1976 event, this project provides essential, policy-relevant insights into the UK’s current resilience. The findings reveal how post-1976 infrastructure and regulatory shifts have altered systemic risk, offering a translatable framework for cross-sectoral decision-making and long-term adaptation planning in the face of climate uncertainties.

PRESENTATION 43

A multi-method assessment of extreme drought for water resources management with climate change in East Anglia

Jane Thurgood

Climate change is increasing the risk of extreme droughts in East Anglia which will impact the water supply, farming, and local ecosystems. Looking at historical drought patterns by analysing past climate data, such as tree rings, we can begin to understand how droughts have behaved over time and allow for a deeper understanding of drought frequency, severity, and duration. By combining this long-term climate information with modern research methods, the project aims to uncover the effects of climate change on drought in East Anglia.

PRESENTATION 123

Managing Drought in Scotland in a Changing Climate: Insights and Lessons learned from the 2025 Drought

Claire Tunaley, Stephen McGuire and Ellen Willmott

Scotland experienced one of its most challenging drought years in 2025, with prolonged periods of below average rainfall resulting in extremely low river flows and groundwater levels. Beyond its severity, the drought displayed distinctive characteristics that may offer a glimpse of the climate conditions Scotland can expect more frequently in the future. Presented from the perspective of the Scottish Environment Protection Agency (SEPA), we cover how developing hydrological conditions are tracked; how water scarcity is assessed and reported; and how regulatory decisions are made to protect the environment whilst maintaining sustainable water use. The 2025 event is contextualised using historical data, with particular focus on the roles of changing snow cover, enhanced convective rainfall intensity, and rapid transitions between droughts and floods. The presentation discusses emerging characteristics of future droughts in Scotland and explores their potential ecological and regulatory implications. It outlines work undertaken since 2025 to address these challenges, including the backdating of water scarcity datasets to improve spatial and temporal understanding of historical drought development, and research to better understand how different drought characteristics influence ecological recovery. These insights are informing the development of more climate resilient water management strategies for Scotland.

PRESENTATION 90

Delivering a well-adapted water resources system, resilient to climate change and extreme drought – stochastic hydrology and climate change impacts in practice.

Steven Wade, Susana Almeida, Lauren Petch, Chris Counsell & Rebecca Welsh. AtkinsRealis, JTA, HR Wallingford

The Water Resources Management Planning (WRMP) process requires water companies to maintain water supplies in a 1 in 500 yr drought and be resilient to future climate change. Global temperatures from the past three years (2023-2025) averaged more than 1.5°C above the pre-industrial level (1850–1900), marking the first time a three-year period has exceeded the 1.5°C limit1. In the UK , water companies are increasingly facing challenges of seasonal and longer duration rainfall, flow and recharge deficits at the same time as periods of high demand due to hotter springs and summers and changing socioeconomic conditions.

This presentation will take a practitioners view on how stochastic hydrology and climate projections are applied in WRMPs and how evolving guidance is being implemented for both regional water resources groups and case study water companies. It will present the impacts of extreme drought and future climate change based on the final plans published in WRMP24 (e.g. WRSE, 2026), and then various updates in methods for WRMP29, including the evolution of further gridded stochastic data sets and changes in how UKCP18 are applied to assess impacts associated with warming levels of 2oC and 4oC above pre-industrial.

Based on learning and expert elicitation from the consultants, regulators and water companies it will set out approaches for WRMP29 and potential improvements for future plans that remain practical, but also aim to deliver well-adapted water resources system by 2050, resilient to climate change and extreme drought.

PRESENTATION 115

Improving the representation of droughts through the application of alternative conceptual model structures

Beskeen, T., Ocio, D., Dezelski, I., Bentley, A., Darch, G., Sampson, M. and Clark, D

Recent widespread adoption of the GR6J rainfall-runoff model in support of water resource management planning for UK water companies has delivered improvements in the ability to represent historical droughts in model calibration and validation. However, the GR6J model, along with all lumped models commonly used in the UK, struggles with influent behaviour and rivers ‘drying up’. This behaviour is observed in many rivers but is particularly prominent in the Anglian region, where rivers can have downstream flows that are lower than upstream contributions (whether natural or artificial) and where groundwater augmentation contributions can rapidly disappear downstream. Rivers ending in water level managed reaches, are also known to ‘lose’ water, though evidence can be more limited due to a lack of formal gauging stations. The recent drought in 2022 also exhibited flow recessional behaviours in Anglian rivers that existing well-calibrated models were not able to replicate, mirroring longstanding challenges with fitting the severe drought of 1976. This presentation outlines the results of a pilot study undertaken in the Anglian Region on alternative conceptual model structures and how these structures

are improving the characterisation of drought behaviour of our rivers. It will also touch on the current roll out on the preferred alternative model structure more widely across the Anglian Region in support of WRMP29.

PRESENTATION 107

A Markov-Based Framework for Analysing Drought Dynamics Across Great Britain

Nishant Gaur, Encarni Medina-Lopez, Lindsay Beevers

Droughts, characterised by gradual onset and indistinct termination, remain one of the most challenging natural hazards to detect, monitor, and manage. While Markov Chains (MC) have been applied to drought prediction, their potential for characterising drought evolution dynamics remains underexplored, particularly under a changing climate. This study investigates spatiotemporal shifts in drought dynamics across Great Britain using the Standardized Precipitation Index (SPI) and Standardized Streamflow Index (SSI) at 1, 6 and 18-month timescales, using the eFLaG dataset with 12 UKCP18 precipitation realisations and 48 streamflow modelling chains (G2G, GR4J, GR6J, and PDM). The time series is partitioned into three periods: observed (1989-2018), near future (2020-2049),far future (2050-2079). MC transition matrices are constructed for each period across 133 catchments and 9 climate districts. Non-parametric permutation test assesses for statistically significant changes between periods. The MC are decomposed using downward mobility and a new metric, dry-state persistence. Results show southern catchments exhibit a consistent tendency toward drier conditions across all indicator timescales, while northern catchments show similar tendency primarily at longer timescales in future. Dry-state persistence increases across all catchments for shorter timescales, though at longer timescales a clear east-west divide emerges, with majority of western catchments showing decreased future persistence. These findings advance understanding of future drought dynamics and inform drought preparedness.

PRESENTATION 55

Developing Drought Triggers for St Helena

Miranda Foster, Evangelia Kordomenidi, Rhiannon Bryan

St Helena is a small (122km^2) volcanic sub-tropical island located in the South Atlantic Ocean, approximately 16km by 10km. It faces a number of long-standing and emerging challenges in managing its water resources, driven by its geographical isolation, limited freshwater availability, and increasing vulnerability to climate variability and change.

We have developed water resources management and drought plans for St Helena drawing on UK water resources and drought planning best practice, while recognising St Helena's unique context of limited storage, variable rainfall, and connectivity constraints.

This presentation describes how we have developed drought triggers, trialling different potential triggers before deciding on a combination of standardised precipitation indices (SPI) indicators with target reservoir stocks for 3 operational areas. The triggers are based on average modelled stocks, with drought status also dependent on other drought indicators such as demands and SPI, to give advance warning of drought conditions prior to reductions in reservoir stocks.

The Plan provides:

- A monitoring framework and indicators used to assess drought status;
- Trigger levels and the process for confirming drought stage;
- Action options by stage (including operational, demand and emergency measures);
- Governance and communications arrangements for escalation; and
- A recovery and stand-down process.

The framework has been discussed with the operational and emergency planning teams, and will be refined through drought planning exercises and feedback after drought events.

Session 9 Climate change & hydrological extremes — floods

PRESENTATION 75

Combining a national-scale grid-based hydrological model with an initial-condition climate ensemble and downscaled events for flood modelling

Alison Kay, Rosie Lane, Adam Griffin, Oscar Martinez-Alvarado and Ben Harvey

Developing an understanding of the potential impacts of climate change on river flows is important for adaptation planning, but for extremes the influence of natural variability at a range of timescales can make distinguishing the forced response more difficult. An initial-condition large ensemble (LE) of the Hadley Centre Global Climate Model (GCM) was produced in the CANARI programme to address this, and allow better sampling of extremes. The 60km resolution is relatively course for hydrological modelling over Britain, especially for high flows, so selected high precipitation events were dynamically downscaled from the LE using a nested Regional (12km) and Convection Permitting (2.2km) climate model (RCM/CPM). These data have been used to drive the Grid-to-Grid hydrological model over GB, using two temporal modelling chains setup for each selected event — GCM-RCM-GCM and GCM-RCM-CPM-RCM-CPM — as well as solely using the GCM data. For the two chains, the GCM data were used prior to each event, to set appropriate antecedent conditions, before switching to RCM data for a short period available before each event, then using either RCM or CPM data for the event itself. Simulations then switch back to coarser data after the event, to try to allow sufficient time for river flows to propagate downstream in larger catchments. We show results comparing the simulated river flows for the three sets of simulations for selected events, illustrating how high flow simulations can differ and why. Possible further analyses are also discussed.

PRESENTATION 79

Decoupling rainfall and flood risk in a changing climate: Spatial variability in pluvial flood drivers

Molly Asher, Paul Bates, Jeff Neal, Leanne Archer, Laura Devitt, Elizabeth Kendon, Gemma Coxon

Projected increases in extreme rainfall are often used as a proxy for future pluvial flood risk, yet flood response depends on a broader set of hydrometeorological controls. Antecedent soil moisture, soil properties, and event characteristics all influence how rainfall is translated into runoff, but their combined role under climate change remains poorly understood.

This study uses high-resolution UKCP Local climate projections to investigate the dominant drivers of future pluvial flood risk across the UK, focusing on the interplay between rainfall, antecedent soil moisture, and catchment properties. Pluvial flood response is simulated using the hydrodynamic model LISFLOOD-FP, enabling direct assessment of how changes in hydrometeorological conditions translate into impacts.

By analysing changes in both precipitation and soil moisture fields alongside modelled flood responses, the work examines how the relationship between rainfall and flooding may shift under future conditions, and how this varies across locations. The analysis will identify the relative importance of different drivers and assess whether changes in flood risk are governed primarily by rainfall intensification or by shifts in antecedent and environmental controls.

This work aims to provide a more process-based and spatially transferable understanding of future flood risk, highlighting the need to move beyond rainfall-only perspectives in climate change assessments of pluvial flooding.

PRESENTATION 116

Impacts of climate and land-use change on water quality, floods, and droughts for catchments in Northern England

S M Reaney, I Pink and A Neill

Climate and land-use changes are projected to significantly impact the hydrological functioning of catchment systems, affecting the frequency of flood and drought events, dominant hydrological pathways, and conditions for biogeochemical processes. These landscape changes will alter the magnitude and timing of sediment and nutrient exports, potentially having a considerable effect on ecological health and ecosystem services. To evaluate potential changes, we modelled 10,000 km² of river catchments in Yorkshire, encompassing agricultural, moorland, and urban areas, using the HYPE model. This model was applied at a 0.5 km² resolution to give a detailed representation of soil type, topography, and land cover. The model was validated with 20 years of data within the GLUE uncertainty framework, producing an ensemble of 25 model parameter sets. Future scenarios are based on the 12-member ensemble from the UKCP18 2.2 km convection-permitting Regional Climate Model under the RCP8.5 global

emissions scenario. The combined uncertainty generated a set of 300 parameter and climate-model simulations. This ensemble was applied to land-use change projections from the CRAFTY-GB dataset. The results suggest that hydrological extremes (both low and high flows) are likely to become more severe. Additionally, water temperatures are expected to rise by up to 5 ℃. Hydrological and water-temperature shifts are driven by projected climatic changes, but land-use scenarios can notably influence suspended-sediment and nutrient concentrations

PRESENTATION 42

‘Weather whiplash’ past, present and future: Understanding the UK’s hydrological transitions

Rachael Armitage, Eugene Magee, Amulya Chevuturi, Wilson Chan, Jamie Hannaford

With the intensification of the hydrological cycle, floods and droughts are increasing in severity and frequency, thus driving rapid swings between extremes, with the UK experiencing many such events in recent years. Most recently, spring-summer 2025 was notably dry but was bookended by wet periods and widespread floods. These transitions between hydrological extremes present complex challenges for water management.

We define a transition as the period between consecutive yet opposite extremes at seasonal timescales. Using a threshold-based method, we identify hydrological and meteorological transitions and calculate their magnitude, duration, intensity, and frequency. We use the eFLaG dataset (1980-2080) to assess projected changes in UK transitions over historical and future periods. We also use this method to frame the 2025 hydrological extremes in the context of a transition event for comparison with transitions in the observational record. The methodology can be extended further to assess transitions since the late 19th century with reconstructed river flows and multi-model projections from new large ensemble simulations (e.g. CANARI LE) to more comprehensively sample the range of transition events in historical and future climate.

Our results provide the first comprehensive look into the spatial distribution of transitions in the UK, showing higher intensity and frequency of transitions in the north-west. These findings demonstrate the risk of increasing hydrological volatility across the UK, with implications for water resources management and climate adaptation.

PRESENTATION 145

Hydrological Response of Coastal Catchments to Land Cover Change: Insights from SWAT Modelling

Rossana Escanilla-Minchel, Joseph Holden, Mark Smith

Understanding the hydrological impacts of land cover change under strong climate variability remains a key challenge, particularly where the El Niño Southern Oscillation (ENSO) may obscure underlying signals. Previous analyses in coastal catchments of central Chile indicate that vegetation changes are associated with shifts in the precipitation-streamflow (Q-PP) relationship, with reduced runoff ratios linked to native forest loss and expansion of exotic plantations.

This study applies a physically based hydrological model (SWAT) to explore how land cover dynamics and climate variability influence streamflow responses. The model was implemented for three catchments with contrasting vegetation trajectories and calibrated using a 45-year dataset (1979-2020). Model performance was robust across all catchments (efficiency metrics >0.65-0.82), capturing both seasonal and interannual variability.

Scenario-based simulations were used to assess the sensitivity of streamflow to different land cover configurations. Results suggest that land cover composition leads to measurable changes in the Q-PP relationship, with stronger differences under contrasting scenarios. In comparison, the influence of ENSO variability appears less distinct in the modelled responses.

These findings highlight the importance of maintaining heterogeneous landscape configurations to enhance catchment resilience and sustain water resources under increasing drought pressure.

PRESENTATION 31

Digital Smart Flood Warning Systems: Piloting LoRaWAN for Surface Water Resilience in West Yorkshire

Paul Maddison

Surface water flooding is an escalating challenge across the UK, threatening over 325,000 properties. Because surface water risk is highly localised and difficult to predict, communities and responders are often reliant on

reactive management. The West Yorkshire Flood Innovation Programme is addressing this gap through the Digital Smart Flood Warning Systems project, which explores how smart technologies can support earlier, more effective flood response.

Using Long Range Wide Area Network (LoRaWAN) technology, the project is testing real time water level monitoring and digital alerts to enable faster response and more targeted maintenance of flood infrastructure. Multiple LoRaWAN based pilot studies are underway across West Yorkshire, led by the University of Leeds and Leeds, Wakefield and Kirklees councils, supported by live dashboards that integrate sensor data to inform operational decision making.

As well as being low cost and flexible, early results show that LoRaWAN can provide quicker and more accurate alerts, helping responders act rapidly to protect homes, infrastructure and businesses. Next steps include scaling sensor deployment, integrating features such as automated road closure signs and gully blockage detection, and exploring wider non flooding applications of LoRaWAN technology.

Our presentation will demonstrate how low cost technological innovation can enable smarter decision making, allowing management authorities to prioritise maintenance, deploy resources efficiently and act proactively rather than reactively.

Session 10 Ecohydrology, water quality & environmental hydrology

PRESENTATION 27

Quantifying current and future benefits and limitations of Nature-based Solutions for nutrient pollution management in rural catchments

Barry Hankin, Hannah Champion, Eleanor Pearson, Robert Davidson, Nicola Wood, Paul Smith, Rosie Holmes, Mary Baldwin, Caitlin Rees, Jenny Broomby, John Robotham, Harriet Orr, Ben Surridge, Philip. M. Haygarth

Agricultural diffuse pollution limits ecological status in many UK catchments, driving commitments to reduce loads by 40% by 2038. Nature based solutions (NbS) can improve rural water quality by reducing nitrogen, phosphorus and suspended sediment loads while delivering wider co benefits, but their effectiveness is poorly evidenced at the catchment scale.

Robust assessment of NbS requires models that represent distributed hydrological and biogeochemical processes. HYPE is well suited as an unsteady, process based model simulating rainfall runoff and nutrient and sediment transfers using soil–land class units. The England wide CSF HYPE model is calibrated and climate change enabled to assess catchment sensitive farming interventions. This study evaluated present day and future water quality benefits of riparian buffer strips, cover crops and wetlands within CSF HYPE, using individual and combined scenarios supported by sensitivity testing with literature based efficacy rates. Results show NbS can reduce nutrient concentrations, with combined measures delivering the greatest catchment scale reductions. Effectiveness varies by scale, catchment and nutrient due to differing controls on runoff, mobilisation and attenuation. Climate change responses are strongly seasonal. Buffer strips and cover crops perform best in cooler, wetter months, whereas wetlands treat a greater proportion of low flow runoff and may decline in efficiency under some futures. Spatially targeted, mixed NbS are more likely to deliver robust, year round benefits within integrated catchment management.

PRESENTATION 105

Typologies and Risk Mapping of the Impacts of Treated Sewage-Related Phosphorus on the Groundwater-Dominated English Chalk Rivers

Keneilwe Maduo Makwati-Manyepedza, Peter Shaw, Justin Sheffield

The ecological degradation of English chalk rivers, despite improved sewage treatment to reduce phosphorus (P) load, suggests that groundwater-surface water (GW-SW) system responses remain poorly understood. Current sewage regulatory frameworks overlook catchment-specific hydrological characteristics that govern P transport and P standards do not account for GW-SW connectivity, as there are no groundwater P targets. This gap highlights the need to re-evaluate P management in chalk catchments, where groundwater may act as a long-term pathway. This study develops a P pollution risk framework that integrates typologies of vulnerability derived from hydrological characteristics with threats based on P loading estimates to both surface and groundwater.

Results show clear spatial patterns in chalk catchment types, reflecting underlying hydrological variability. At the waterbody catchment scale, three types emerge: two less vulnerable catchments (one with higher elevations and deeper groundwater tables; another predominantly overlain by a secondary bedrock aquifer) in southern England and one more vulnerable (with thicker, more extensive secondary drift aquifer) in the north. Ongoing analysis of consented discharges shows that over the past seven decades, permitted discharges have increased, with treated sewage discharges to surface and groundwater varying across catchments, suggesting a growing threat and potential future risk, given the long-term role of groundwater. These findings highlight the need for catchment-specific sewage regulation and integrated water management.

PRESENTATION 16

Modelling historical and future flooding (1970–2080) to evaluate risks to earthworm communities

Qiuyu Zhu, Megan Klaar, Kristian Daly, Michael Berenbrink, Ben Pile, Mark E. Hodson

Earthworms play a crucial role in soil structure, nutrient cycling, and ecosystem resilience, but the pressures they face from extreme weather and soil flooding will intensify under climate change. Although earthworms possess physiological, behavioural, and life history adaptations that provide some resistance to temporary inundation, prolonged flooding sharply reduces soil oxygen, creating conditions that challenge their survival. Understanding how changing flood characteristics influence earthworms requires a temporally and spatially resolved view of flood dynamics.

To address this, we developed a UK-wide rain-on-grid flood modelling framework (1970-2080) driven by historical climate observations from HadUK-Grid and future UKCP18 climate projections. The resulting flood hazard metrics provide detailed representations of inundation regimes, including the extent and duration of soil saturation and the changing frequency of future flood events. These flood characteristics were integrated with experimentally derived earthworm tolerances to low oxygen conditions. We generated spatial hazard and vulnerability maps that highlight areas where increasing flood frequency and duration surpass earthworm survival thresholds.

The results reveal emerging hotspots where future flood regimes may reduce the viability of earthworm communities, with consequences for soil functioning and resilience. Our work demonstrates how climate driven hydrological extremes propagate ecological risks and highlights the need to incorporate potential ecosystem impacts into climate adaptation strategies.

PRESENTATION 109

Vegetation water uptake strategies under soil water-limited conditions in a temperate rainforest in Scotland

Aline Meyer Oliveira, Marc-Andre Cormier, Josie Geris

Vegetation water uptake strategies play a key role in determining resilience to climate change. Trees can exhibit opportunistic behaviour during drought, shifting uptake to deeper, wetter soil layers. However, these strategies remain less understood in wet climates, where vegetation is adapted to wetter conditions. Therefore, such ecosystems may be particularly vulnerable to drought, and the behaviour of interspecies water use under water stress is largely unknown. In this study, we investigated the water uptake strategies of mature oak trees and blueberry understory vegetation under soil water-limited conditions using stable water isotopes as tracers in a temperate rainforest in Scotland. We collected samples of soil and vegetation water fortnightly over the 2025 summer in a rain-exclusion plot and in a control plot. We used a mixing model to determine contributions of shallow (0-10cm) vs. deeper (10-60cm) soil water sources to oak and blueberry understory vegetation water use. Preliminary results indicate that both oak and blueberry have preferential uptake from shallow soil layers. We found that the upper 10 cm provided ~61-70% and ~60-69% of oak and blueberry total water use, respectively. Interestingly, neither species shifted towards deeper water sources despite significant topsoil drying (up to ~60% decrease from initial water content), contrary to recent findings for other temperate species. These results suggest similarity in rooting strategies under water stress between oak and blueberry, with potential implications for the resilience of temperate forests.

PRESENTATION 108

Monsoon effects on urban groundwater quality in South Asia: a case study in Pokhara, Nepal

Tim Muller, James Hart, Binod Heyojoo, Sophie Horton, Sarah Mager, Bishnu Devkota

Monsoon climates have a fundamentally different hydrological regime with high-intensity recharge after lengthy dry seasons, which may mobilise and dilute contaminants in urban aquifers. Few studies have documented the change in ground water levels (GWL) and water quality (GWQ) across the monsoonal wet/dry seasons. We address this gap by reporting on our study into monsoonal forcing of groundwater in Pokhara, Nepal, which has 4+ m/yr of rainfall into a highly permeable karst aquifer. The research quantifies the relative importance of mobilisation versus dilution across the full monsoon transition by high-frequency (weekly-to-monthly) GWQ sampling coupled with near-continuous rainfall, electrical conductance, and GWLs. Preliminary results indicate frequently elevated nitrate concentrations (>50 mg/L WHO drinking water standard, with a max. 360 mg/L). It appears contamination is greatest in areas with shallow groundwater and dense population, and peaks at the start of the wet season before returning to baseline levels. Conductivity reduction pulses of hundreds to approx. 1,000 µS/cm were also observed due to short-term dilution from heavy rainfall, suggesting rapid flow through the aquifer. Based on these observations, it is suggested that contaminant mobilisation dominates early in the wet season, with sustained dilution through the mid-late wet season as GWLs increase by up to ~30 m. Elevated contaminant concentrations generally appear to be short-lived, so short-term interventions early in the wet season could be targeted to reduce risks of drinking water contamination.

PRESENTATION 18

Investigating the hydrologic impacts of open drain blocking in grassland peat soils

Hilary Pierce, Owen Fenton, Eve Daly, Asaf Shnel, David O'Leary, Mark G. Healy, Patrick Tuohy

Grassland peat soils are commonly artificially drained using open surface drains and in-field pipes to increase agronomic production on these waterlogged lands. The lowering of the water table in these areas leads to the release of carbon dioxide. Research has found that raising the water table after drainage has a positive impact on reducing the net warming impact of greenhouse gas emissions from grassland peat soils. There are an estimated 300-350,000 ha of permanent grassland on peat soils in Ireland, of which 80,000 ha are targeted in the Climate Action Plan for reduced management intensity, which may involve active water table management.

The Department of the Agriculture, Food and the Marine-funded project, REWET, aims to provide a deeper understanding of the hydrologic impacts of drain blocking on grassland peat soils. Seven field sites on grassland farms with varied enterprises and intensities in the midlands were selected and classified into peatland type. Sites were instrumented with rainfall gauges and fully-screened dipwells with pressure sensors to monitor water table depth. At five sites ditch blocking infrastructure to raise the water table were installed and four sites were instrumented with soil moisture sensors to measure volumetric water content. Preliminary results indicate differences in the effectiveness of blocking surface drains based on peat soil parent type and peat thickness and show that surface drain blocking may only impact the water table in a small area near the drain block, which may limit its impact on mitigating greenhouse gas emissions.

Session 11 Water resources — planning, management & policy

PRESENTATION 77

River Severn regulation: challenges and opportunities

Lizzie Quarmby, Natalie Armitage, Kate Evans and Phil Betts

The River Severn is the longest river in Great Britain, travelling approximately 354 km (220 miles) from its source in Plynlimon down to the Severn Estuary. It provides a major source of water for public consumption, industry, hydropower generation, navigation and agriculture and is recognised for its environmental importance, providing habitats and a migratory corridor for nationally and internationally important species.

The Environment Agency regulates the River Severn in conjunction with Natural Resources Wales and with input from water companies and Canal and River Trust. We manage releases from Clywedog and Vyrnwy Reservoirs and the Shropshire Groundwater Scheme to maintain the statutory five day mean flow at Bewdley of 850Ml/d. We also manage the reservoirs in winter to reduce the amount of spill, benefitting local communities downstream of the reservoirs.

Regulating the River Severn can be challenging and collaborative working is critical to its success. Stakeholders have conflicting needs, forecasting the releases required can be difficult given the data and weather forecasts available and water resources are being squeezed.

We are addressing these and future challenges through a large-scale review of a system that has been operating in a similar way for many years. We know change is needed given pressures on water resources and the environment, so we've commissioned projects to improve our understanding of the system and its resilience. Interactions with Strategic Resource Options and water company supply options will also affect how we operate the system.

PRESENTATION 60

Water for Cambridge: Use of pumping station data to inform catchment water balance discussions

Roberto Quaglia & Jennifer Murphy

The Water for Cambridge project developed an analytical framework to understand how water abstracted from multiple pumping station catchments and managed within a complex interconnected system would be impacted by new winter abstraction. This presentation describes the methods used to define catchments, construct water balances, and quantify how existing abstractions would impact the water availability for further abstraction. Pumping station catchments were delineated using control structures, operational boundaries and local knowledge. Winter catchment specific water balances were developed to quantify available volumes and used to test the contribution of each pumped catchment, providing a common basis for comparison across the system and exploring wider hydrological interactions. A key element of the methodology was the apportionment of pumping hours across the pumping stations. Total monthly pumping hours were provided for the project but needed to be apportioned into a daily time series and across differing sizes of pumps. Sensitivity testing was used to understand how changes in assumptions, such as differing pumping thresholds impacted water available. The resulting catchment balances were used across the wider catchment to understand the impacts of reduced pumping on Hands-off Flow requirements, impacting the number of days of available abstraction. The presentation shows how water balance calculations have been applied within the Water for Cambridge project as an evidence base for understanding system and catchment behaviour and informing optioneering stages.

PRESENTATION 65

Wise Use of Water- Water balances in low-lying catchments

James Fidal, Matt Savill, Max Tant and Priscilla Haselhurst

The North Kent Marshes face growing pressures on water use from climate change, farming abstractions and competing land use demands. To date, water management planning in the area focused primarily on water levels for sites with ecological designations, hence there was a need to refresh the water level management plans and broaden their scope. Due to the low-lying nature of the catchment, managed waterways, differing soil types and lack of hydrological data, this catchment posed a number of challenges to model hydrologically and hydraulically.

The approach for the study linked a conceptual soil moisture model with water use, retained water levels, overland storage and hydraulically inter connected sub catchments, to create catchment water balances. These water balances, mapped the movement of water within each catchment to a tidal outfall.

Key findings showed that, summer water scarcity is present across all catchments with some areas already experiencing the drying of water storage, the impact on ecological sensitivities due to climate change and the impact on tidal infrastructure from sea-level rise.

These results highlighted where retention, potential adjusted abstraction and cross-catchment flow management can effectively sustain habitats whilst also providing the required water usage. With the study highlighting opportunities for a more integrated water management approach.

PRESENTATION 133

From Hydrological Signals to Action: Deploying a Temporary Use Ban During Rapidly Escalating Drought Conditions

Aodhín McBride, Steve Tuck, Laura Beardsworth

Increasing pressures on water resources during extreme summer conditions are intensifying the challenge of maintaining public water supply while protecting the environment. In 2025, Thames Water implemented a Temporary Use Ban (TUB) in the Swindon and Oxfordshire Water Resource Zone in response to rapidly evolving hydrological stress and escalating water resources risk. This presentation provides a technical overview of the hydrological conditions leading up to the intervention, including groundwater and surface water behaviour, demand patterns, and short term drought indicators. We describe the analytical framework used to assess system risk, the operational triggers that informed decision making, and the evidence base that supported both the introduction and subsequent removal of the TUB. The session will offer insight into how real time data, modelling outputs, and environmental considerations were integrated into a dynamic management response, and will reflect on lessons learned for future drought planning and adaptive water resource management.

PRESENTATION 20

Reframing drought resilience: the role of raw water quality

David Ocio, Mott MacDonald; Tom Beskeen, Mott MacDonald; Kieran Murnane, Mott MacDonald; Geoff Darch, Anglian Water; Mark Sampson, Anglian Water

Through several cycles of water resources planning, there has been an increasing focus on the availability of water in drought conditions. However, little attention has been given to the potential impact of worsening raw water quality conditions due to climate change or during critical droughts. This contrasts with operational experience, where poor water quality commonly causes disruption to river abstraction.

One way of improving the consideration of water quality-induced outage is to predict when raw water quality at the location of river intakes will exceed operational thresholds, which could trigger an abstraction outage within a system-based model, leading to a more reliable estimation of deployable output.

Water quality modelling can be adopted to this effect in the same way rainfall-runoff modelling is applied routinely in water resources planning. However, existing water quality models are often too complex, trying to represent too many processes, or too simplistic, lacking the desired temporal variability.

New parsimonious water quality models, fully integrated with the GR6J rainfall-runoff model, have been developed to fill this gap. They cover suspended solids, nutrients, and pesticides and have been tested in the Nene and Bedford-Ouse catchments upstream of Anglian Water raw water intakes at Wansford and Offord. The models have shown how dynamically coupling water quality related outage with water availability has the potential to reduce deployable output more than predicted by current practice and help inform related mitigation strategies.

PRESENTATION 124

Fully integrated surface and groundwater modelling with MIKE SHE and MIKE+ for the River Thames Scheme in London

Philipp Huttner, Birgitte von Christierson, Mike Cope, Zdenek Hosek, Zoltan Trabak

The River Thames Scheme (RTS) in Surrey and southwest London is the UK's largest inland flood defence project, primarily designed by Binnies. Modelling covered fluvial, groundwater, surface water, water quality, and sediment transport processes.

To support design, stakeholders and the Environment Agency adopted a fully integrated, process-based modelling approach. This replaces simplified assumptions with physically based simulations, capturing interactions between surface water, groundwater, and evapotranspiration.

The RTS model uses MIKE SHE coupled with MIKE+ Rivers, representing rivers, Thames weirs, operational rules, and lake bathymetry. This online coupling enables accurate simulation of groundwater heads, river and lake levels, and discharges, allowing the system to behave like a natural catchment and improving predictions under changing conditions.

The planned channels will alter groundwater regimes and the regional water balance. Only a fully coupled model can reliably represent these interactions by capturing feedback between water bodies and land processes. Simulations of floods and droughts enabled predictions of groundwater and lake level variations, as well as

phosphate and nitrate dynamics. Combined with residence time analysis, this supports detailed assessment of nutrient enrichment and algal bloom risks in planned lakes.

For complex projects like RTS, integrated modelling with MIKE SHE is essential, as separate simulations would increase uncertainty and reduce reliability.

PRESENTATION 14

Improving flood resilience to Scotland's distilleries

David Cameron

Scottish whisky is essential to Scotland's economy, contributing over £5bn (Scottish Whisky Association). In recent years, existing distilleries have expanded production and many new distilleries have been developed. Flooding presents a key risk to many distilleries, from sources including fluvial, coastal, surface water and drainage. This is likely to become even more so in the future under climate change. Providing flood resilience while meeting crucial environmental regulations can be a significant challenge. Through the use of real world examples, this talk will highlight options for improving flood resilience at distilleries, including benefits and constraints.

Implementing flood resilience measures at distilleries is highly relevant to Scotland's Flood Resilience Strategy, notably the outcomes for People, Places and Processes, as follows. People: distilleries are a critical source of employment in many communities, often with small communities based around the distillery; improving flood resilience would therefore help safeguard jobs and communities. Places: appropriate flood resilience must align with appropriate land management, including NPF4: flood resilience at a distillery should have a neutral or better effect on others up and downstream. Processes: implementing flood resilience at a distillery can require collaborative working with others such as nearby communities, ideally to help reduce overall flood risk.

Session 12 Early Career Hydrologist showcase: data-driven methods & tools for the next generation

PRESENTATION 99

Explainable AI Reveals Global Patterns and Controls of Runoff Elasticity

Pei Xue, Dominick Spracklen, Joseph Holden

Understanding how runoff responds to hydroclimatic variability is critical for anticipating future water risks. We analyse runoff elasticity, defined as the proportional change in runoff relative to precipitation, across 9,663 global basins from 1955 to 2014 using Random Forest and Temporal Convolutional Networks to quantify its spatial evolution and dynamic drivers. High elasticity regions remain spatially persistent over time, indicating stable underlying hydroclimatic controls. Temperature is the most widespread driver, while soil water and snowmelt regulate spatial structure, and mid latitudes form a transition zone with competing controls. Under perturbation scenarios, sensitivity increases across mid to high latitude regions of the Northern Hemisphere and decreases in parts of the tropics and Southern Hemisphere. These results suggest that runoff sensitivity is likely to intensify in regions experiencing increasing atmospheric demand, while weakening in areas where water availability constrains hydrological response. Overall, this study provides the first global, observation-based, assessment of the long-term dynamic controls of runoff elasticity across thousands of basins, offering new insights into the mechanisms governing hydrological sensitivity and improving our ability to anticipate future changes in water availability under climate change.

PRESENTATION 119

UK-Flow15v2: Next steps in developing sub-hourly river flow observations for the UK

Felipe Fileni, Matt Fry, Hayley Fowler

UK-Flow15 (https://doi.org/10.5285/211710ac-f01b-4b52-807f-373babb1c368) provided the first national-scale 15-minute river flow dataset for the UK, with >1.8 billion observations from 1,369 stations (1948–2024). Its release addressed a key gap in sub-daily hydrology and enabled large-sample analyses. Since its release, the dataset has seen a lot of use, averaging approximately 1.5 downloads per day.

Building on this, UK-Flow15v2, developed within the Floods and Droughts Research Infrastructure (FDRI), focuses on improving the consistency, transparency, and coverage of the 15-minute dataset, with an emphasis on clarifying the relationships between the different flow products used across the UK.

We have reassessed existing stations, incorporated additional flow gauges, and integrated river level measurements together with corresponding flow observations, enhancing both scientific analyses and data quality evaluation. In parallel with the curation of stations, FDRI is developing a framework to enable continuous updates to the dataset, starting with an extension to 2025. This effort aims to ensure long-term maintenance and accessibility of 15-min river flow records.

Together, these developments advance UK-Flow15 as a robust, evolving national resource, supporting improved understanding of sub-daily hydrological processes and enabling future large-sample hydrological research.

PRESENTATION 132

Development of Rainfall Typologies Incorporating Drop Size Distributions and Their Synthetic Replication Using a Rainfall Simulator

Ruth E. Dunn, Amy C. Green, Elizabeth Lewis, Hayley J. Fowler

Rainfall is typically described by how much falls—but not how it falls. Yet droplet size distributions strongly influence rainfall measurement accuracy, as well as infiltration, runoff, erosion, and sediment transport. Despite this, most rainfall typologies rely solely on intensity.

This study introduces a new rainfall classification for the UK that integrates droplet characteristics using disdrometer data from the national Disdrometer Verification Network. Three distinct rainfall types are identified, representing contrasting droplet size structures, and combined with intensity thresholds linked to shifts in microphysical behaviour. This provides a more physically meaningful framework for describing rainfall.

To support application, a portable rainfall simulator was developed to replicate selected rainfall types, enabling controlled testing of how both intensity and droplet structure affect measurement accuracy. This work offers a new way to characterise UK rainfall and a practical tool for evaluating its impacts across hydrological and meteorological applications.

PRESENTATION 25

“We Do Our Best”: Regulatory Capacity and the Decline of Freshwater Monitoring in England

Madison Wright, Paul Kay, Anna Mdee, Vincent Moran, Ruth Sylvester, Paul Hutchings.

Freshwater monitoring generates evidence to assess water quality, inform enforcement, and communicate risk. In England, this function is conducted by the Environment Agency (EA) despite declining budgets and staffing levels. Using the River Nidd (North Yorkshire) as a case study, this work examines long-term changes in freshwater monitoring and the conditions shaping data use. We combine quantitative analysis of over 200,000 water-quality monitoring records (1963–2024) with semi-structured interviews with EA staff (n = 9). Monitoring frequency declined substantially: average annual EA measurements between 2013-2023 (2430/year) were 52% lower than under the National Rivers Authority (1989-1996). While quantitative analysis focuses on the Nidd, interviews offer broader insight into monitoring across England, indicating that declines reflect erosion of institutional capacity, not increased efficiency. Under constrained resources, statutory monitoring is prioritised, often at the expense of local investigation and response. Although monitoring continues, the ability to analyse, interpret, and act on data has weakened, producing a paradox of data abundance and analytical deficiency. Without capacity, expanded monitoring risks reinforcing procedural compliance without improving data utilisation. These findings also help explain the growing prominence of community-led monitoring, emerging in response to gaps in how environmental data are interpreted and acted upon. This highlights the need for more integrated approaches to data use across hydrological monitoring systems.

PRESENTATION 52

A collaborative approach towards the shared science of intermittent chalk streams

Eugene Magee, Nathan Rickards, Kevin Collins, Sunita Sarkar, Cedric Laize, Peter Scarlett, Nick Everard, Charles George, Catherine Sefton

Whilst the value of perennial river systems has long been understood, that of intermittent rivers has only more recently been recognised. The hydrology of the intermittent reaches of chalk streams is dynamic, from highly attenuated baseflow-dominated regimes to low flows and drying of the channel. The variability of drivers in both time and space results in marked differences in flow states at the same location at different times of year. These factors give rise to a broad range of perceptions, explanations and uncertainties across local communities, water companies and regulators, about the relative importance of local and wider factors on intermittent behaviour.

To help improve the collective understanding of chalk streams with intermittent flow reaches, four streams in the south-east of England were chosen to explore and provide a new and shared understanding of their behaviour. Local groups were engaged to contribute their experiences and understanding of their chalk streams, and stakeholder-led outputs were produced based on innovative monitoring and analysis techniques including flow-state maps, thermal imagery and updated habitat survey classifications. The next steps in the project will focus on understanding the common features in the dynamic nature of chalk streams through additional analysis, monitoring, and citizen science, providing further insights into their behaviour and helping to inform both the policy and sustainable management of these systems going forward.

Section 2: Posters

Listed in abstract-number order. Each entry shows the final title, authors, and abstract.

POSTER 11

Intensity–Duration–Frequency (IDF) Design Rainfall Framework for Turkey: A Practical Tool for Engineering Applications

Fatih TOSUNOGLU and Thomas Rodding KJELDSEN

Intensity–Duration–Frequency (IDF) curves, linking rainfall intensity, duration, and return period, are essential for hydrologic design and flood risk management. This study addresses limitations in existing IDF models in Turkey, where research often targets limited basins or short records and lacks practical tools for engineers. Turkey's diverse climate causes high spatial variability in rainfall extremes. To address these gaps, we develop a nationwide, statistically robust, and practitioner-oriented IDF framework by compiling and rigorously quality-controlling long-term sub-daily rainfall extremes (ranging from 30 minutes to 24 hours) from 193 stations. We assess spatial and temporal trends, evaluate candidate probability distributions (including Lognormal, Gamma, Weibull, and Logistic) to identify the optimal fit, construct regional IDF curves, and develop a user-friendly tool for rapid rainfall intensity estimation. The framework aims to unify rainfall design practices and support resilient infrastructure, flood mitigation, and sustainable water management across Turkey.

POSTER 12

Non-stationary Modelling of Annual Maximum Flows in Türkiye: Integrating Physically Based GAMLSS Models with Climate Change Projections

Fatih TOSUNOGLU, İsmail YÜCEL, Ercan KAHYA, Osman Furkan TOKGÖZ and Berkin GÜMÜŞ

Flood frequency analysis is a key tool for estimating extreme hydrological events required for the planning, design, and management of water-related infrastructure. Traditional approaches assume stationarity, meaning that extreme hydrological series are independent and identically distributed over time. However, this assumption has become increasingly questionable due to climate change and anthropogenic influences, which may introduce trends or abrupt shifts in hydrological extremes. Consequently, nonstationary probability distribution models have received increasing attention. This study develops physically based nonstationary probability distribution models for annual maximum streamflow in the Çoruh Basin, Türkiye. Unlike conventional time-based approaches, the parameters of the probability distributions are expressed as functions of physically meaningful hydro-climatic variables. Flood quantiles and associated risks are estimated for both the historical period and future climate projections under multiple Shared Socio-Economic Pathway (SSP) scenarios, including SSP2-4.5, SSP4-6.0, and SSP5-8.5.The results provide a comprehensive evaluation of how physically based nonstationary models represent extreme streamflow behaviour compared with stationary approaches and how projected climate change may influence future flood magnitudes and risks, offering insights for climate-resilient water resources planning and infrastructure design.

POSTER 13

Private Water Supply resilience in rural Scotland

Jamie Ledingham

Private Water Supplies (PWS) represent a small, but important contribution to water supply, with around 3% of the Scottish population reliant on one. However, for a number of reasons they do not typically receive either the regulatory attention or the level of technical assessment afforded to larger water users.

Prolonged periods of dry weather in Spring and Summer 2025 resulted in a number of domestic PWS failing, in some cases despite previously having been identified as suitable for delivering a supply. When these failures occur, they can create significant economic and social problems in rural communities and can place a burden on both local authorities and public water utilities.

This presentation outlines some of the specific challenges of water resources assessment in some PWS catchments and identifies why some of the existing technical methods for assessment perform poorly. The role of a hydrologist working in tandem with supply users to gather field data and insights on system behaviour will be explored as well as improvements to both assessment methods and practical measures that all help to ensure the resilience of these types of supply.

POSTER 21

Assessing uncertainties in a cascading climate-flood-finance model chain

Qiuyu Zhu, Mark Trigg, Polly Foster, Emily Estcourt, David Wilkinson

Uncertainties in climate-related flood risk assessments are increasing under climate change, driven by multiple sources including climate projections, flood modelling frameworks, and data availability. To identify and quantify these sources of uncertainty and to better constrain decision-critical variables, we developed a cascading climate-flood-finance modelling chain for the River Hull catchment.

The model chain coupled multi-ensemble RCM projections with a precipitation-driven flood hazard model for the ~1100 km² River Hull catchment. We implemented a rain-on-grid flood modelling approach using standard Flood Estimation Handbook (FEH) design rainfall events, enhanced with climate-projection-derived uplift factors. Spatial variability in rainfall was represented using a centroid-based method, allowing us to define sub-areas that exhibit differing rainfall intensities and concentration patterns. To account for seasonal differences in extremes, rainfall events and uplift factors were classified by winter and summer.

Flood hazard outputs were then integrated with geospatial financial exposure datasets to estimate potential financial losses. The findings emphasise not only the increasing relevance of climate-informed financial planning and regulation but also the need for decision-useful, transparent, and scientifically robust modelling frameworks. Clear communication of assumptions, limitations, and uncertainties between climate scientists, hazard modellers, and financial analysts is essential for credible climate-risk assessment and effective adaptation planning.

POSTER 22

When and where are abstractions and wastewater discharges crucial for streamflow modelling? Insights from large sample analysis and hydrological modelling in England

Yanchen Zheng, Gemma Coxon, Francesca Pianosi, Ross Woods, Mostaquimur Rahman, Laura Devitt, Ponnambalam Rameshwaran, Nicholas Howden

Water resources across the UK face growing pressures from climate change and anthropogenic activities. Abstractions and wastewater discharges significantly alter streamflow, yet many hydrological models omit or oversimplify these processes, limiting performance in human-influenced catchments. Understanding when and where these influences matter most is essential for water resources management, particularly in densely populated and water-stressed regions such as South-East England.

This study exploits a unique water resource management dataset comprising decades-long records of monthly surface water and groundwater abstractions (1999–2023) and daily wastewater discharge time series (2005–2015) for thousands of locations across England. We first analyse this dataset to characterise the spatial and temporal variability of abstractions and discharges, identifying when and where river flows are most affected. We then implement abstraction and wastewater discharge modules within the DECIPHeR-GW hydrological model and quantify resulting improvements in streamflow simulations. We also identify conditions under which neglecting these processes leads to substantial model degradation. Scenario-based experiments assess how water resource management data should be represented in models, including the importance of temporal patterns, providing practical guidance for modelling human impacts in data-scarce regions. Our findings offer actionable insights for improving hydrological modelling and supporting water resources planning across England.

POSTER 23

Toward a National Understanding of River Chemistry: Analyzing Water Quality Baselines and Controls across Great Britain from the new CAMELS-GB-Chem dataset

Nicholas Howden, Yanchen Zheng, Francesca Pianosi, Ross Woods, Gemma Coxon, Penny Johnes

Large-sample datasets have become increasingly valuable for understanding and modelling hydrological processes. Recent studies demonstrate that integrating large-scale water quality data can reveal new insights into baseline conditions and their controls. However, such datasets remain scarce despite rising global river pollution.

We compiled approximately 64 million water quality records for Great Britain's rivers by harmonising datasets from Natural Resources Wales and the Environment Agency of England. These records were matched to catchments within CAMELS-GB, a large-sample hydrology dataset with hydro-meteorological timeseries and catchment attributes for 671 catchments. Rigorous quality assurance procedures were applied to address detection limits,

outliers, and duplicates. We aim to release this harmonised CAMELS-GB-Chem dataset for national-scale river water quality analyses.

Using CAMELS-GB-Chem, we characterise baseline water quality and trends across Great Britain, and explore links to catchment attributes including climate, hydrological signatures, geology, soils, land cover, and topography. Preliminary results show that climatic variables (e.g., aridity, mean rainfall) and streamflow metrics (e.g., Q95, mean discharge) are dominant controls, while land cover, geology, and soils exert varied influence across different indicators. Our work fills a critical national-scale data gap and provides a foundation for monitoring, modelling, and managing river water quality under environmental change.

POSTER 28

Impacts of meteorological droughts on groundwater resources across Europe

Aimee Lenthall; Shams Rahman

Groundwater is a critical natural resource. It is relied upon by billions of people globally to provide freshwater for drinking water, agriculture and industry, as well as supporting a wide range of groundwater-dependent ecosystems. This crucial resource is threatened by groundwater droughts, which are defined as extended periods of below-normal groundwater levels, with profound impacts on society, the environment and economy. Yet, our understanding of groundwater drought has historically been limited by the inadequate availability of in-situ groundwater data, alongside deficiencies in our current understanding of the capabilities of existing models to reproduce the key features of groundwater drought. Using newly-available in-situ observations from around 2,000 groundwater wells, obtained from the International Groundwater Resources Assessment Centre (IGRAC), alongside a parsimonious groundwater model applied across Europe, this study aims to address this knowledge gap. By comparing model outputs to in-situ data, the ability of the model to reproduce the variability in groundwater drought characteristics across the continent is explored. Next, the model's ability to propagate meteorological droughts to groundwater is assessed. Initial findings indicate that droughts become longer but less intense during propagation to groundwater, with high spatial variability in the resulting drought characteristics. This has important implications for water resource management across this region.

POSTER 30

Understanding and Modelling Drought-to-Flood Transitions in Great Britain

V. Kington, F. Pianosi, L. Devitt, G. Coxon, C. Hutton

Hydrological transition events pose major challenges for water resources management and risk resilience in Great Britain. Drought-to-flood events in Britain are of particular interest, as they can have severe consequences for water supply, illustrated by the 2010-12 transition event, which placed major pressure on water companies and led to temporary water-use restrictions affecting over 20 million people, before record rainfall triggered extensive flooding (Marsh et al., 2013). However, analysis of transition events is hindered by their rarity in observational records, ambiguity in definition, and the complexity of catchment processes that govern them.

This study investigates the occurrence and controls of drought-to-flood transitions across Great Britain and evaluates how well hydrological models capture them. Using daily observed streamflow data from CAMELS-GB v2 (Coxon et al., 2025) for 1980 to 2022, and model simulations from the UKCEH Hydro-MIP, droughts, floods, and transition are identified and compared. Analysis examines transition spatial distribution, duration, and frequency, and explores the influence of catchment characteristics, such as hydrological regime, land use, and lithology.

This work aims to address key questions surrounding the occurrence, controls, and simulation of historic drought-to-flood events in Great Britain. Specifically, it examines how the frequency and duration of transitions vary across Great Britain and what controls them, how well hydrological models capture them, and which aspects of process representation may explain differences in model performance. Event definitions are also explored in relation to catchment type and management perspective.

POSTER 32

A parsimonious approach to integrating reservoir operations in large-sample hydrological modelling across Great Britain

Z. Mei, Y. Zheng, G. Coxon, F. Pianosi

Hydrological models are essential tools to simulate and understand natural hydrological processes. However, their performance is often limited in regulated basins due to insufficient representation of human activities and water infrastructure. As a typical form of human intervention, reservoirs can significantly alter natural flow regimes, and their inclusion in hydrological modelling remains challenging.

Here, we develop simplified reservoir operation rules for water supply reservoirs in Great Britain (GB) to improve hydrological simulations in reservoir-regulated catchments. Based on publicly available observed reservoir storage data, we analyse the multi-year monthly dynamics of reservoir storage across different regions. This helps define the initial storage conditions and minimum storage thresholds, thereby simplifying the parameterization of the operation rules. Considering the differences in water abstraction practices, we classify reservoirs into direct abstraction and downstream compensation abstraction, with corresponding logics describing their impacts on flow regimes. We integrate these rules with the widely used GR6J lumped rainfall-runoff model and apply to more than 200 regulated catchments across GB. We compare simulations with and without reservoir component to evaluate model performance according to multiple performance metrics.

We aim to assess GR6J performance in regulated catchments and develop a parsimonious approach to improve it. Our work will benefit water resources managers by supporting more reliable flow simulations and informed decision-making.

POSTER 33

Modelling Nature Based Solutions using 2D hydraulic models: the challenge of estimating hydrological inputs.

Rozy Shepherd

A whole catchment natural flood management (NFM) feasibility study was carried out for the Gala Water, that involved the development and validation of a catchment wide 2D HEC RAS hydraulic model. The modelling aimed to assess how natural and engineered NFM measures could help reduce flood risk downstream at Stow and Galashiels. As the model used a 2D grid with direct rainfall as the hydrological input, model calibration was essential. This included refining hydrological parameters (initial and maximum soil moisture, Cini and Cmax, and storm duration) from running observed rainfall events in ReFH2 to calibrate hydrograph shape. The observed net rainfall and baseflow (calculated from ReFH2) was run in the model, and the model outputs compared with observed flows at the Galashiels gauge. Direct rainfall modelling requires caution, as models may not fully represent runoff processes, but performance from the Storm Frank event in the hydraulic model showed reasonable calibration to the observed peak flow at the Galashiels gauge, giving confidence in the model's ability to simulate catchment response.

FEH Statistical peak flow estimates were derived from single site analysis at the gauge and a hybrid method was used to generate design hydrographs from ReFH2 for NFM scenario testing. Overall, the study found that the model provided a validated basis for assessing NFM options and their potential to reduce flood risk in the catchment. The work was undertaken by JBA Consulting with active involvement from Scottish Borders Council and local catchment knowledge shared by Tweed Forum.

POSTER 34

Automated Land Cover Classification for Hydrological Modelling

Brice Richardson

With large scale land cover changes due to urbanization, agricultural intensification, and rewilding in pursuit of NetZero and ecological targets, there is a pressing need to evaluate the impacts of land cover changes on water resources. Satellite imagery offers a promising source of data, with regularly recurring sampling. However, research on the use of satellite imagery to inform land cover classification in hydrological models is sparse, in spite of extensive use of satellite imagery for other applications and regular parameterization of land cover in hydrological models. This research presents a novel workflow that utilizes Landsat 8/9 images to classify land cover for input into the physically based, spatially distributed hydrological model, SHETRAN. The study focuses on the Coalburn, a data-rich catchment situated in the north of the UK, which has alternated between forest and grassland cover as a result

of reforestation and logging. A cloud-mask and surface reflectance factor are applied to raw satellite imagery, then scenes are aggregated to form a summer mosaic image. Forest cover is identified using the normalized burn ratio, converting continuous index values to a forest/ grassland binary to reflect catchment characteristics. Model performance is evaluated using Nash Sutcliffe Efficiency and Kling Gupta Efficiency metrics, with results indicating that the satellite imagery land cover classification accurately simulates streamflow. This represents a stride in efficiency, defensibility, and reproducibility of land cover representation in hydrological models.

POSTER 37

Designing a real-time whole system monitoring approach to better understand the hydrological cycle during floods and droughts: the River Chess

Kate Heppell, Denise Pallett, James Sorensen

The River Chess is one of the three nationally representative catchments selected as part of the Floods and Droughts Research Infrastructure (FDRI) project. The River Chess is representative of catchments that are permeable, in relatively warmer and drier parts of the UK, with urban pressures. Such permeable catchments have dynamic catchment boundaries that do not align with the topographic catchment, an absence of surface water bodies over much of their surface area, and extensive non-perennial river reaches. Groundwater flooding is the most common form of flooding that can persist for months, and the extensive subsurface storage can assist in buffering the riverine impacts of meteorological drought. In urbanised catchment, such as the Chess, surface flooding can also arise from high intensity rainfall events falling on impermeable surfaces. Such events are predicted to become more frequent under future climate scenarios. Designing a monitoring network to better understand the development of drought in permeable catchments will offer valuable insights for water resources management. Key science priorities include a better understanding of river-aquifer interaction, water quality, understanding water storage and movement through the landscape, and closing the water balance; all during extremes. We present our approach for a whole system catchment monitoring design to address the science priorities in these types of catchments and welcome feedback and engagement from the hydrological community.

POSTER 41

Overview and insights from the Flood Hydrology Improvement Programme

Sarah Bazley, Anita Asadullah, Selena Peters

The Flood Hydrology Improvements Programme (FHIP) is the first step in delivering the vision of the UK Flood Hydrology Roadmap and one of the most comprehensive efforts to modernise UK flood hydrology.

Led by the EA and working in collaboration with the UK nations, FHIP brought together experts from across the hydrological community to improve hydrometric data, methods and ways of working. Together they have laid the foundations for modernising UK flood hydrology, paving the way for future improvements.

This poster showcases the breadth and ambition of that work.

It draws together key insights gained through delivering a multi-year, multi-organisation improvement programme, showing where real progress has been made and where further innovation is needed.

The aim is to celebrate collective achievement and spark conversation about the future direction of flood hydrology in the UK.

POSTER 45

The Upper Severn floods and droughts observatory: science priorities and monitoring network design

Kieran Khamis, Jade Hatton, Laura Holliday, Catherine Wilson

The NERC funded Floods and Droughts Research Infrastructure (FDRI) aims to improve understanding and management of risks associated with hydrological extremes. FDRI includes three research catchments (instrumented observatories), of which the Upper Severn is the most westerly and, along with the Upper Tweed, is broadly representative of the UK uplands (i.e. wet and on low permeability geology). Upland catchments with topographic variability, mixed land cover and strong spatial gradients in precipitation are often highly dynamic and difficult to model and therefore require instrumentation networks monitoring at high spatiotemporal resolution. Here we present the science priorities guiding the catchment monitoring design for the Upper Severn observatory,

including, a need for: 1. higher frequency observations (i.e. 1 min) to better represent the timing and magnitude of peak flows, 2. improved understanding of water source and flow path dynamics under hydrometeorological extremes, 3. whole system monitoring to constrain uncertainty in key fluxes (i.e. close the water balance), and; 4. fusion of earth observation and point scale measurements to quantify inputs (precipitation) and soil storage. We hope that our approach for whole system catchment monitoring will stimulate debate amongst the wider hydrological community and we welcome feedback.

POSTER 48

Hydrological modelling and analysis for assessing SSSI flow compliance.

Katie Russell

Sites of Special Scientific Interest (SSSIs) are designated to conserve important ecological and natural features, with the natural flow regime of rivers a key control in this. Artificial influences, including abstractions and discharges, can alter these regimes, and may contribute to unfavourable status. Climate variability can also modify the baseline flows, exacerbating the relative impact of these pressures. Assessment of natural and influenced flow regimes is therefore required to determine compliance with the Common Standards Monitoring Guidance (CSMG) flow targets, ultimately informing SSSI flow compliance status.

This project applied a framework to assess SSSI flow compliance status in a number of catchments. Where available, gauged flow data was used to represent influenced conditions, with Probability Distributed Modelling (PDM) explored to simulate the influenced rainfall-runoff response at ungauged locations. Influenced flows were then naturalised using abstractions and discharge data. Deviations from the natural flow were quantified using flow percentile metrics and temporal analysis to determine compliance with the CSMG targets.

Flow compliance results are presented for each SSSI unit, both temporally and spatially. By integrating hydrological modelling with water resources data, this approach therefore provides a practical means of assessing SSSI flow status in both gauged and ungauged catchments, with the results more widely useful in supporting targeted management interventions under increasing climatic and demand pressures.

POSTER 49

Developing a Gauge–Radar Merged Precipitation Dataset (1 hour and 1 km) for Great Britain: GRaD-GB (1H1K)

Xiaobin Qiu, Amy C. Green, Stephen Blenkinsop, and Hayley J. Fowler

High-quality precipitation data are essential for hydrology and flood-risk assessment in Great Britain (GB), yet existing datasets remain limited. Rain gauges are accurate but sparse, while radar provides spatial detail but contains significant errors.

This study presents the GRaD-GB (1H1K) dataset, a new hourly 1 km gauge–radar merged precipitation dataset for GB (2006–2023). Radar QPEs are first evaluated against ~1300 gauges, showing systematic errors, especially for high-intensity rainfall. A rule-based quality control framework reduces RMSE by ~29% and increases correlation coefficient by ~31%. A Gauss Blending Method (GBM) is then used to merge quality-controlled radar with gauge observations (~970 gauges), producing spatially complete rainfall fields while preserving local structure. Independent evaluation (~194 gauges) shows improved accuracy and better detection of high-intensity rainfall compared with radar-only and standard methods.

The final GRaD-GB dataset (~1300 gauges + radar) provides a consistent, high-resolution rainfall product for GB and is designed for direct use in hydrological modelling, flood-risk assessment, and analysis of sub-daily extremes.

POSTER 51

National River Flow Archive: The UK's Focal Point for Hydrometric Data

David Crowhurst, Gayatri Suman, Stephen Turner, Isabella Tindall, Jamie Hannaford

The National River Flow Archive (NRFA) is the UK's primary archive of hydrometric data, holding records from over 1,600 gauging stations, including those operated by the four UK Measuring Authorities. The archive is maintained by the UK Centre for Ecology & Hydrology (UKCEH), where new annual data submissions undergo comprehensive quality control before publication.

Daily mean flows form the core of the Archive, and since 2015 it has also included the national Peak Flow Dataset, used for flood estimation following Flood Estimation Handbook methods. Users can download daily flow, peak flow and catchment rainfall data from the NRFA website or via the API.

NRFA data support a wide range of activities, including water resource assessment, water management planning and climate change analysis. Long records, some extending to the 19th century, allow users to identify trends and place recent floods and droughts in historical context. NRFA data also underpin the National Hydrological Monitoring Programme, which provides authoritative monthly summaries of UK hydrological conditions.

Recent developments include a redesigned website with an improved search function, making it easier for users to access the data they need, as well as the release of the latest Version 14 Peak Flows dataset in 2025, incorporating new catchment descriptors and updated methods.

Through sustained long term stewardship, the NRFA team ensure that reliable hydrological data and expert advice are available to support research, policy and water management needs both within the UK and internationally.

POSTER 53

Beyond UKCP18: River flow changes from a large initial-condition climate ensemble for the UK

Wilson Chan, Nathan Missault, Rosanna Lane, Amulya Chevuturi, Alison Kay, Rachael Armitage, Eugene Magee, Hadush Meresa, Adam Griffin, Pallavi Goswami, Jamie Hannaford

Perturbed parameter ensembles like UKCP18 consider a relatively small number of ensemble members and mixes uncertainty related to climate model parameterisations and natural internal variability, complicating the robust estimation of risk. The CANARI project recently delivered the UK's first 40-member single model initial-condition large ensemble (CANARI LE) using the Met Office climate model (HadGEM3), designed to systematically sample the range of internal variability.

Here, the CANARI-LE is used to develop multi-model national hydrological projections for the UK. Six catchment hydrological models (GR6J, HBV, FUSE implementations of the ARNO, PRMS, TOPMODEL and SACRAMENTO models) and a GB national gridded hydrological model (G2G) are used to simulate river flows. Modelled rainfall is bias corrected using trend-preserving quantile mapping while potential evapotranspiration, calculated with the Hydro-PE method, is scaled to match historical estimates. Bias correction, conducted by pooling all ensemble members, maintains ensemble spread and preserves the range of internal variability.

Results show that the range of plausible floods and droughts are better sampled, with compound events (e.g. hot-dry events, multi-year droughts) particularly benefiting from a larger sample size. Extremes within the CANARI-LE may complement existing ensembles and stochastic methodologies to develop stress tests for scenario planning. On-going work will explore the added value of the CANARI-LE for studying the drivers of floods/droughts, hydrological transitions and other compound hazards.

POSTER 56

Twenty years of Rapid Response Catchments; time for a change?

Vicky Shackle and Oliver Francis

Work to define Rapid Response Catchments began around 20 years ago, after exceptional flooding in Boscastle, North Cornwall. Since then, advances in computational power, forecasting products, improvements in national scale datasets, and updated hydrological methods all suggest that it would be possible to re-imagine the register of risk catchments. These were the motivators for this study.

A pilot study has looked at outcomes for 25 locations in Devon and Cornwall, applying the Desktop Method and comparing results to the current status of the catchments on the register. The impact of using local data was investigated where possible.

Key findings were that the existing Desktop Method has serious limitations in regard to rainfall, runoff, cross section and roughness calcuations, and shows inconsistencies with the more complex Automated Method. For small catchments, Tp(0) values were so low that storm durations were less than the minimum allowed by FEH of 0.25 hours.

Some of the questions arising from the analysis will be examined in this presentation. For example:

- Is it still helpful to define Rapid Response Catchments?
- If the RRC designation is to continue, how can the methodology be improved?

- Should the criteria for defining a Rapid Response Catchment be re-considered?
- What is the role of local data if a national methodology is needed?
- Can NaFRA2 help at all?

POSTER 57

Flood peak reduction from temperate rainforest restoration.

George Porton, Simon Webb, Dominick Spracklen, Tom Willis, Steph Bond

Woodland restoration is widely promoted as a natural flood management strategy, yet not all woodland types provide the same benefits. Many modelling studies overlook this by treating woodland as a uniform land cover.

We investigate whether restoring temperate rainforest, characterised by high non-vascular vegetation cover, both in the canopy and on the ground, affects flood risk differently from broadleaf woodland.

Using SD-TOPMODEL, we simulated flood hydrographs under scenarios of increasing woodland or temperate rainforest cover. Temperate rainforest was assigned a higher interception rate than broadleaf woodland, reflecting the influence of increased non-vascular vegetation.

Results show that for every 10% increase in catchment temperate rainforest cover, peak flood flows were reduced by 4.44%, a 1.91-fold greater effect than for broadleaf woodland.

Our findings demonstrate that restoring temperate rainforest, and the non-vascular communities that define it, could provide disproportionately high flood mitigation benefits. Restoring temperate rainforest is therefore not only a biodiversity priority but also a highly effective strategy for reducing flood risk.

POSTER 59

Water for Cambridge: How stakeholder engagement shaped feasible optioneering solutions

Yvonne Riley & Jennifer Murphy

The Water for Cambridge project adopted an engagement led approach to optioneering, recognising that, in the hydrologically complex and highly engineered South Levels system, knowledge of current operators was crucial to identifying feasible water management solutions. Early and ongoing engagement with stakeholders, including regulators, operators, landowners and farmers, directly shaped the development and enhancement of feasible options to identify integrated water resource solutions that needed to be technically robust, environmentally resilient, and deliverable. During the optioneering phase, discussions with the Environment Agency, Anglian Water, Cambridge Water, Internal Drainage Boards, landowners and farmers, informed the initial Red–Amber–Green assessment of source options, conveyance routes, and end uses. These conversations provided early insight into operational constraints, abstraction and permitting considerations, and environmental sensitivities, allowing options to be screened and refined. Stakeholder input influenced the comparative assessment of solutions by incorporating societal and environmental considerations. Options aligned with catchment objectives, potential biodiversity or placemaking benefits, or reduced perceived community impacts were differentiated from solutions with limited wider value, such as standalone pipeline conveyance. The presentation demonstrates that engagement is a core technical input to optioneering, in turn improving decision quality, de risking delivery, and enabling solutions to respond to both system needs and communities.

POSTER 63

Characterising Global Hydrological Extremes and Transitions

Jessica Dimond, Lindsay Beevers, Simon Moulds, Vasily Demyanov, Sandhya Patidar

Climate change is intensifying the global hydrological cycle, with potential impacts on the magnitude and frequency of extremes. While flood and drought impacts are often quantified in isolation, rapid transitions between the two can exacerbate impacts on water management, water quality, riverine ecosystems, agricultural productivity, wildfire and landslide risks. Hydrological extremes and transitions are complex and disentangling climate change from human influences remains a significant challenge.

This work draws on the ROBIN (Reference Observatory of Basins for International hydrological climate change detection) dataset of streamflow across global near-natural catchments, allowing us to isolate the effect of climate change on floods and droughts. We develop a robust threshold-based methodology for characterising global hydrological extremes and transitions, assessing changes in their magnitude, frequency, duration, and timing, and

identifying spatial distributions and temporal trends. Floods are detected using peaks-over-threshold while droughts are detected using a combined consecutive dry period and threshold level method, ensuring representation of perennial, intermittent and ephemeral flow regimes. Our initial results show that global hydrological extremes are sensitive to the choice of threshold method (fixed, variable, or seasonal) and level (percentile or frequency-based). Our findings provide a robust method to detect extremes and transitions globally, supporting improved decision-making and future preparedness, with implications beyond hydrology.

POSTER 66

Prolonged Dry Weather in the North East of England in 2025

Vicky Crichton and Rachel Merrix

In 2025, the North East of England experienced an unusually long spell of dry weather. Unlike previous events, the dry conditions began early in the year, leading to prolonged environmental and hydrological impacts. This poster will illustrate how the dry period developed, using rainfall and flow data in graphs, tables and maps to show how the rainfall deficit varied over time and how this impacted river flows. It will also highlight key record-breaking aspects of the event. This work is important because it demonstrates the North East's vulnerability to dry weather. There is a common public perception that the presence of Kielder Water guarantees both a plentiful water supply across the North East and protects the entire region from the impacts of environmental drought. However, Kielder and it's associated transfer system can only support certain major rivers and many other areas of the North East remain vulnerable to the effects of prolonged dry conditions. We will include several examples from 2025 where impacts were observed on rivers that are not supported by the Kielder system.

POSTER 71

Exploring uncertainty in flood risk estimates using low-complexity modelling

L. Brusasco, R. Woods, R. Lamb, F. Pianosi

Flood risk is modelled as the interaction between hazard, exposure and vulnerability, each affected by uncertainty in inputs and modelling choices. Uncertainty and sensitivity analysis are used to understand the key sources of uncertainty and how they propagate through the flood risk modelling chain. Hydrodynamic models are widely used to estimate flood hazard; however, their computational cost constrains uncertainty analysis, as large ensembles of simulations are required. The effort needed to run these analyses limits their application across multiple catchments, reducing the number of studies that investigate uncertainty in flood risk modelling. As a result, it remains difficult to compare catchments to understand how and why the sources and magnitude of uncertainty vary between them.

This work develops a low-complexity framework to analyse uncertainty and sensitivity in flood risk modelling at catchment scale. The approach uses geomorphic floodplain representation based on Height Above Nearest Drainage (HAND) to estimate hazard, combined with functional relationships derived from hydrodynamic model outputs. This enables analysis of the full flood risk modelling chain while retaining key controls.

Initial testing is carried out on UK benchmark catchments using flood maps and hydrodynamic outputs as reference, assessing the ability of the framework to represent flood behaviour and support comparison across catchments. The framework shows potential to support uncertainty analysis of flood risk estimates and to group catchments according to similar risk response profiles.

POSTER 74

Hydrogen Electrolysis and Global Clean Water Supply: Assessing the Hydrological Implications of a Green Hydrogen Economy

Wathsala Rathnayake

The rapid expansion of green hydrogen as a decarbonisation pathway has raised critical questions about its implications for global clean water supply, particularly in regions already experiencing water scarcity. This study evaluates whether large scale hydrogen production through renewable electrolysis places additional pressure on freshwater availability. Using a qualitative literature-based approach, the research examines the water requirements of electrolysis, the feasibility of seawater desalination and wastewater deionisation, and the water-oxygen balance inherent in the hydrogen cycle. Findings indicate that producing one tonne of hydrogen requires approximately nine tonnes of purified water however, the process is fundamentally water-neutral, as hydrogen

oxidation returns an equivalent amount of water to the hydrological system. Seawater and wastewater can be treated to meet electrolysis standards, reducing reliance on limited freshwater reserves, but both processes encounter significant financial and energy costs. These costs are substantial challenges for developing nations with limited water-treatment infrastructure. The study concludes that green hydrogen does not inherently threaten global clean water supply, yet sustainable implementation will depend on investment in affordable purification technologies and integrated water-resource planning to ensure equitable and resilient hydrogen deployment.

POSTER 78

Experiences in sense checking in flood hydrology

Heather Forbes

Sense checking hydrological results is an important component within the flood modelling process. However, this step can often be treated as a formality. I have therefore compiled some useful examples of good practise in sense checking, what to look for and what to do with unexpected results.

The peak flows dataset has been assessed using the UKFE R package, to compile a list of indicative 100-year growth factors and specific discharge values for gauged sites across the UK. In my poster I will provide examples of how I have used this dataset in recent modelling projects to sense check results. My examples will also demonstrate cross-discipline working across hydrology and hydraulic modelling.

Key findings include examples of:

* Typical ranges for 100-year growth factors and specific discharge values.

* The investigation of an unusual result.

* Using flood outlines to guide improvements.

The examples are intended to influence engagement with sense checking. With the FEH calculation record under review I aim to highlight sense checks as an important feature of the calculation process."

POSTER 82

A standardised groundwater recharge index to aid water resources planning under climate change

Rachel Pugh, Anna Murgatroyd, Jim Hall

Standardised indices are widely used to identify, describe and monitor droughts, providing a quantified comparison between events. For groundwater droughts, metrics including the Standardised Groundwater Index (SGI) are commonly used. However, their application for water resource management may be limited by data quality or availability. We explore whether an alternative index, the Groundwater Recharge Drought Index (GRDI), can provide complimentary insight into groundwater drought evolution for water supply. GRDI is a parametric distribution index allowing standardised comparison of groundwater recharge and identification of drought events from recharge anomalies. We demonstrate the validity and effectiveness of GRDI for water resources planning in the Thames Basin in England, using an extensive hydrological dataset covering historic simulated observations and future UKCP18 climate projections. Exploration of the propagation of drought signals in the historical record demonstrates the advantage of GDRI in estimating groundwater recharge for drought monitoring and early warnings, relative to other groundwater level indicators. Finally, examples of future drought events, simulated based on climate model projections through to 2080, are compared to historic conditions to demonstrate the benefits of GRDI to contextualise future drought risks within water resource management planning.

POSTER 84

Automated HEC-RAS Monte Carlo Integration (AutoRamtin)

Ramtin Sabeti; Abdalaziz Hamdan, Thomas Kjeldsen; Ioanna Stamataki

Uncertainty analysis of complex models such as HEC-RAS typically requires either simplified methods or approximations. We present here a new open-access tool that allows users to incorporate HEC-RAS into a Monte Carlo framework and thus allowing for a full uncertainty analysis. The presentation will demonstrate application to a range of case studies, including translation of uncertainty in design floods into uncertainty in design water levels and uncertainty in reconstructing historical events.

POSTER 87

Exploring Machine Learning methods for the estimation of daily flows in – catchments

Andy Taylor & Tracey Haxton

The estimation of flows in un-gauged catchments remains a central hydrological challenge, underpinning key regulatory requirements relating to water resources, water quality, flooding and climate change adaptation. Traditional hydrological models widely used in the UK for these purposes include lumped conceptual models (e.g. PDM and GR6J), semi-distributed models (e.g. CERF, Grid2Grid) and physically based models (e.g. SHETRAN). These provide process interpretability but can be limited by structural assumptions, parameter equifinality, and the need for extensive calibration data. In contrast, machine learning (ML) models learn nonlinear catchment responses directly and can capture behaviours that may be difficult to represent explicitly within these traditional model structures.

We investigate several machine learning approaches, including LSTM, Transformers, Seq2Seq, CNN and GAN, for the purpose of estimation of daily flows in un-gauged catchments. Using 'pooling' techniques similar to those used in traditional hydrological approaches, for example, nearest neighbour or similarities using catchment descriptors, model performance is improved. This is demonstrated in a large number of 'natural' catchments, using NRFA gauged daily flows, MetOffice HadUK gridded rainfall data, and UKCEH Hydro-PE HadUK gridded PE data.

As demonstrated in other studies, ML models generally outperform generalised traditional hydrological models. With care and due diligence, ML models can be used to provide an alternative, rapid and robust method for producing flow estimates at un-gauged sites.

POSTER 89

Resilience to Flooding in Wilayat Al-Seeb, Oman, Using Hydraulic Modelling and An Agent-Based Model of Community Response

Omer Al-Kaabi; Prof. Simon Mathias; Prof. Sim Reaney; Dr. Nima Gerami

Tropical cyclones (TCs) pose significant threats to many coastal communities, causing substantial economic and social losses that are expected to increase due to climate change impacts. Oman's location exposed to a persistent risk of TCs forming in the North Indian Ocean. Over the past 25 years, Oman has faced more than 11 TC events, resulting in many fatalities and economic losses of billions of USD. Strengthen resilience became urgent need as more than 75% of the population lives in a vulnerable coastal zone. Especially, Wilayat Al-Seeb, which accommodates the highest population and has witnessed many extreme weather events. This research aims to develop a comprehensive community resilience evaluation and enhancement model for Al-Seeb, by integrating hydraulic model (2D HEC-RAS) with agent-based modelling (HEC-LifeSim). The approach reveals various interaction among stakeholders and reframe disaster resilience studies in Oman from a traditional theory-based approach to a dynamic and interactive method built on observed flood behaviour with evacuation processes. This presentation will show the flood modelling results and illustrate how changed to the city's infrastructure affect population movement during a flood event and can increase community resilience. The results of flood model of Cyclone Gonu (2007) performed reliably and showed good accuracy when validated against observed water levels. In addition, the ABM findings highlighted existing weaknesses in current resilience and identified the necessary enhancements to strengthen community resilience.

POSTER 91

The hydrology of Strategic Resource Options in England and Wales: Water resources, water quality and consenting challenges on our major reservoir projects.

Steven Wade, Charles Malcolm, Claire Hollingworth and Stuart Smith

The scale of the challenge facing England's water resources over the next 25 years is set out in the Environment Agency's National Framework for Water Resources (June 2025), which outlined a requirement for an additional 5 billion litres of water every day to meet demand by 2055.

In 2024, Ofwat's programme of Strategic Resource Options (SROs) was expanded to 33 major projects, including new reservoirs, large water transfers, and water recycling schemes which are expected to be operational from as early as the 2030s. This is the most significant investment in water resources for more than 30 years and includes several large reservoirs in a range of different hydrological contexts, from storage in headwaters to provide water for high demands in London to reservoirs located at the tidal boundaries of large rivers.

The different hydrological contexts for our new major reservoirs provide significant technical challenges for hydrology, water quality and environmental science to achieve the water supply, environmental and social requirements of each scheme. This presentation will consider hydrological modelling, water quality, Water Framework Directive, aquatic ecology and flood risk work required to achieve successful Development Consent Order applications for storage reservoirs. Taking lessoned learned by practicing hydrologists on a number of schemes it will present a framework for the hydrological assessments required for consenting and permitting, from field monitoring surveys to complex integrated modelling on water resources systems and in-reservoir water quality.

POSTER 93

The role of hydrology in international climate finance: How hydrological insights are influencing the inception and design of global climate action projects.

Steven Wade, Sam Leader, Susana Almeida and Ben Smith

This poster will explore how UK consultant applied climate scientists and hydrologists are engaging with the International Finance Institutions (IFIs) in the inception and design of climate action projects, covering different stages of project design from screening for climate risks through to feasibility and design of flood risk management and water resources schemes in Asia and Africa.

It will include case studies of work with ECMWF on European and Global Climate Hazards Indicators, with the European Investment Bank on Adapting the Agriculture Sector in the Nile Delta and European Bank for Reconstruction and Development on the role of hydrological modelling on major irrigation projects in Central Asia.

A synthesis of project experience will be used to argue why UK Government, UK consultants and universities, should work in partnership to increase our provision of climate and hydrological services internationally, to meet the high demand for services, and deliver positive socio-economic impacts globally.

POSTER 95

Trends in High and Low Flows Across the UK: Evidence from Long-Term Streamflow Reconstructions

Pallavi Goswami, Wilson Chan, Amulya Chevuturi, Jamie Hannaford

Hydrological extremes and the changes in them pose significant challenges for water resource management, flood risk assessment, and drought planning across the United Kingdom. While instrumental records provide valuable insights into recent hydrological variability, their relatively short length limits the ability to distinguish anthropogenic signals from natural variability. Hydrological reconstructions, therefore, provide an opportunity to understand multi-decadal trends, which is often not possible for catchments with short observation records, as is true for many catchments in the UK. This study leverages streamflow reconstructions spanning the period 1891-2015 to evaluate long-term trends in both high and low flows across 305 UK catchments. Using daily flow records, we compute high-flow (Q5) and low-flow (Q95) indices and test these for the existence of multi-temporal trends and shifts to changes in flow regimes over time. This presentation will discuss the results from these analyses, along with providing a comparison of these trends with those obtained from observational records to demonstrate the added advantage of using reconstruction data. The findings highlight the value of long-term streamflow reconstructions in detecting changes in hydrological extremes that would remain undetectable in shorter observational records. Similar methods will be applied to upcoming flow reconstructions from multiple hydrological models to understand model structural uncertainty, and to planned simulations that will extend reconstructed hydrological records further back to the 1850s.

POSTER 96

Field-based Quantification of the effectiveness of offline ponds

MEDHA, Vassilis GLENIS, Claire WALSH

Offline ponds are a widely implemented Natural Flood Management (NFM) measure, with their performance predominantly assessed through modelling studies. However, there remains a lack of field-based evidence quantifying their effectiveness, particularly at the stream scale. This study addresses this gap through analysis of empirical data collected within a monitored catchment in Coatham Wood, North-East England. Two years of high-resolution stage and discharge data were used to identify and characterise high-flow events. Event-based

comparisons of upstream and downstream hydrographs were undertaken to quantify changes in peak flow magnitude associated with the presence of the ponds.

Results indicate a consistent reduction in peak discharge between upstream and downstream locations, demonstrating that offline ponds can provide measurable attenuation during storm events. However, the magnitude of peak flow reduction varies substantially between events. This variability is strongly influenced by antecedent moisture conditions and catchment wetness, which govern available storage within the ponds at the onset of an event.

These findings demonstrate that the flood mitigation benefits of offline ponds cannot be assumed to be constant but are event-dependent and determined by prior catchment state. This has direct implications for how NFM schemes are represented in models, evaluated in practice, and designed for resilience.

POSTER 97

Strengthening Water Resources Hydrology: A community led approach to building skills and capability

Emma Cross, Sally Smith, John Waddingham, Rachel Merrix and Andy Quinn

The water resources hydrology community in the Environment Agency is navigating rapidly evolving pressures, including strategic resource development, population growth, climate uncertainty, and emerging technologies. To respond to these challenges, and through working together as a community, we are implementing our strategic water resources hydrology workforce action plan to strengthen our technical resilience now and in the future. Over the last 5 years, we have been working with our specialist skills and training team to develop new pathways for attracting and supporting talent. This includes hydrology focused mentoring schemes with universities, development of a Hydrology Graduate Training Programme, tailored outreach materials for university career events and academic study opportunities. Building on this foundation, a water resources hydrology community driven future skills action plan has been developed to identify and build the hydrological expertise required over the next 5 years and beyond. This poster will present the outcomes of this initiative and show how our community led approach is strengthening the future of water resources hydrology in the Environment Agency.

POSTER 98

Transforming River Source Information through interactive digital tools

Jess Barnes, Emma Cross, Simon Parry, Jamie Randall

The river source visualisation dashboard was developed to modernise how long-term river source data is accessed, visualised, and interrogated across Thames area of the Environment Agency. Bespoke hydrological monitoring of intermittent rivers has provided valuable long-term records of their hydrological state - dry, ponding or flowing - in response to changing groundwater levels. However, the previous Excel based tools made it difficult to interrogate the data, particularly when rapid insights were required during droughts. At the same time, advances in intermittent stream hydrological science over the last decade highlighted how the hydrological state records gained from the long-term river source data could be better visualised. In response, the Thames Area Water Resources Innovation Group initiated a project to create an interactive, user friendly Power BI river source dashboard to transform data accessibility and improve hydrological insight applying the latest science. The dashboard has transformed data visualisation through enabling greater interrogation of the long-term river source data to support operational water resources decision-making. Developed using in house skills and capability, the dashboard represents a significant step in modernising the way long-term river source data is accessed, visualised, and interrogated in Thames area of the Environment Agency.

POSTER 101

Community Engagement within Natural Flood Management

Esme Callander

Natural Flood Management (NFM) techniques are rapidly infiltrating the flood mitigation scene due to their focus upon sustainable infrastructure. Conscious efforts are made to embody, and simultaneously gently enhance, the existing natural environment. This provides valuable opportunities for improving water and soil quality, alongside replenishing sources of vital biodiversity through creation of habitats. Large-scale projects are often supported by the Scottish Government and SEPA, such as the Tweed Forum project on the Eddleston Water, a tributary of the River Tweed.

However, small, independent projects are often liable to challenges arising from funds and larger stakeholders. Therefore, an integral factor throughout many NFM projects is the reliance upon community presence and influence. For example, a frequent hurdle faced amidst such developments is seeking permission from landowners who may be hesitant to modify their landscape and assets. In instances such as the natural pool management at Pool of Muckhart, the nearby community played a huge role in influencing landowners to adopt NFM principles, which hence, granted the green light for the development of numerous leaky dams. Boosting community engagement in the form of educational workshops and nature-based activities accelerated the drive to change; notably benefiting the vicinity of the site.

It is vital to acknowledge the benefit community engagement has upon such projects within the field of hydrology, and in particular, natural flood management, in the current light of increasing flood risk and climate change.

POSTER 104

The Upper Tweed: A Whole-System Observatory for Hydrological Extremes

Lindsay Beevers, Andrew Black, Laura Holliday, Simon Moulds. School of Engineering, University of Edinburgh, Faculty of Arts & Social Sciences, University of Dundee, British Geological Survey, School of Geosciences, University of Edinburgh

The Upper Tweed (NRFA 21014) is a small upland catchment in the Scottish Borders and one of the three Flood and Drought Research Infrastructure (FDRI) hydrological observatories. Of the three catchments it has the lowest mean annual temperature and potential evaporation, and similar annual precipitation to the Upper Severn. By UK standards the catchment is high and steep, with its mean drainage path slope (224.0 m/km) in the 95th%ile of 671 CAMELS GB catchments. Groundwater flow occurs within fractured and weathered low-permeability bedrock and across a heterogeneous cover of superficial deposits, including head, glacial till, peat, and floodplain sands and gravels.

Land use is dominated by rough grazing and managed forestry, with recent re-wilding and wind-farm developments. There are two reservoirs that supply water to Edinburgh. Surface runoff is likely to be a significant flow pathway during heavy rainfall events, while the relative importance of subsurface flow during flood events is poorly understood.

Key science priorities for the Upper Tweed include a better understanding of the dominant flow pathways in upland catchments during floods and droughts. Its steep topography and relatively high elevation provide the opportunity to quantify the importance of spatial variability of upland precipitation and rain-on-snow events to flood generation. Lastly, the catchment allows the investigation of environmental change and its impact on hydrological extremes. We outline a monitoring design to realise this potential and establish a national hydrological observatory.

POSTER 106

INCREASING THE DIRECT MEASUREMENT OF FLOOD FLOWS

Andrew Black, Nick Everard, Ali Rudd, Simon Moulds, Kirstie Murphy, Louise Ander, Anna Rose Klaptocz

*Peak flows are almost never measured directly

*Technology to the rescue

*How can you help?

In February 2026, the British Hydrological Society co-hosted a technical workshop with the UKRI Floods & Droughts Research Infrastructure programme, to review progress and opportunities regarding the direct measurement of floodplain flows. More than 100 people participated, from all career stages, and from a mix of university, measuring authority, consultancy and research centre backgrounds. Many had no involvement in generating flood flow measurements, but most used them in research applications.

The event heard about the challenges of obtaining direct measurements of extreme high flows. We also heard about rapid developments in technology which are already having transformative benefits: velocity sensing from space, trail cameras and drones; also the use of drones to carry ADCPs across a cross-section. But none of these methods is standard yet.

So where do we go from here? The need is pressing. Can we really afford to inform design and research applications by such uncertain data? We argue that the key is to make the most of technologies and protocols which are available today or still in development, but crucially also to find ways to work together – professional hydrometrists, citizen scientists, students, community groups, to safely obtain velocity data during peak flow events, to scrutinise

them and ensure they are transparently shared to the benefit of the hydrology community. Please talk to us, and share your views!

POSTER 114

Multi-Decadal Trends in Soil-Moisture Drydown Properties

Ffion Joughin Humphreys, Ross Wood, Miguel Rico Ramirez, Rafael Rosolem

The total volume of water stored in soils represents only a small fraction of global water storage. Despite its small volume, soil water plays a crucial role in regulating land–atmosphere interactions, supporting plant growth and health, and controlling how water is partitioned across the water cycle. Anthropogenic climate change has altered many of the Earth's natural pathways and storage processes, yet our understanding of how soil moisture dynamics are responding remains limited. To address this gap, we analyse how annual averages of soil drydowns vary over a 70 year period (1950–2024) using long term reanalysis data, bias corrected to the footprint of 160 Cosmic Ray Neutron Sensing sites, providing accurate estimates of root zone soil moisture. To characterise and attribute observed changes, we derive the shape, magnitude, and timing of drydown events and assess how these characteristics evolve across the 70 year time series. The resulting metrics provide the basis for detecting potential changes in drydown behaviour, identifying controlling factors, and evaluating variability across hydroclimatic and land cover gradients. Mixed effects models and correlation analyses are applied to determine how observed trends in drydown characteristics correspond to concurrent variations in precipitation, evaporative demand, aridity, and other site specific attributes. Together, these combined analyses reveal how soil moisture dynamics have changed through time and identify the climatic and environmental drivers most strongly associated with emerging shifts in drydown characteristics.

POSTER 118

Data-Rich Catchment Networks – the need for continuous, high frequency and long-term observations

David Mindham

While we know most of the possible processes/mechanisms that translate rainfall into streamflow, we typically do not measure enough to know the actual processes/mechanisms of a specific catchment.

Catchments are heterogeneous, rainfall is stochastic, catchment response to a storm is dynamic, and thus no single catchment responds the same why twice and no two catchments are alike. This makes useful application of generalised models to specific catchments awkward. To gain understanding of how a specific catchment functions and build relevant models for the purpose of water resources management, we need lots of observed data. Unfortunately, it is impossible to continuously observe every aspect of a catchment to learn the specific processes/mechanisms, either because it is too expensive, too time consuming, or the act of observing changes catchment behaviour.

However, streamflow represents the overall catchment response to rainfall and is the combined sum of all the processes/mechanisms translating rainfall into streamflow and thus offers a wealth of information, especially when coupled with observed estimates of rainfall.

High frequency, long term rainfall/streamflow timeseries data from a network of micro-basins and from the EA, in Cumbria are explored. Signal Processing, Data-Based Mechanistic, and Machine Learning methodologies are applied to show variance in long term trends, highlight the dynamics of storm response and the influence of catchment state, and assess the predictability of streamflow given the observed spatial and temporal heterogeneity of catchment response.

POSTER 121

Integrated Water Balance Modeling - Sustainable and Climate-Adapted Water Management in the Borken Catchment Area

Philipp Huttner, Zoltan Trabak, Maximilian Winderl, Zdenek Hosek

The Borken region in northern Germany faces increasing water challenges due to climate change and rising demand. More frequent summer droughts and extreme storms heighten risks of water scarcity and flooding, affecting farmers, water suppliers, and industries concerned about reduced water permits. To address this, a fully integrated catchment model was developed to support regional planning, with future plans for real-time monitoring and management.

The model is based on MIKE SHE, allowing high-resolution simulations and integrating all components of the hydrological cycle. It includes a 3D groundwater module for subsurface dynamics and a detailed unsaturated zone model accounting for soil properties, moisture, and evapotranspiration—key for assessing climate and land-use impacts on groundwater recharge.

Surface processes are represented through overland flow simulations, and the system is coupled with a 1D river model (MIKE+) to capture interactions between groundwater and surface water. Human influences such as groundwater extraction, irrigation, drainage, and hydraulic structures are also included.

Unlike conventional models focusing on single components, this approach integrates all hydrological processes. It is calibrated using groundwater levels and river discharge, enabling reliable simulation of groundwater dynamics, peak flows, and overall water balance. The model already supports evaluation of retention measures and helps stakeholders make informed decisions for climate adaptation.

POSTER 122

High resolution modelling of groundwater recharge with MIKE SHE

Philipp Huttner

Due to climate change, water resources are decreasing in many regions of the world. To provide spatially and temporally differentiated assessments of water availability, both the requirements and the data basis for future water rights allocation must be adapted. The current approach for determining groundwater recharge relies on soil water balance models or rainfall–runoff models at the national or federal state level. These models are based on a soil storage approach and separate runoff into direct runoff, interflow, and baseflow. However, many soil water balance models used in Europe neglect temporal variations in groundwater levels and fail to capture dynamics driven by climate change. They are typically calibrated only against river discharge, without incorporating groundwater monitoring data or groundwater–surface water interactions. In the context of climate change, these approaches are no longer sufficient to provide reliable estimates of groundwater availability. New methods have repeatedly been called for that can represent the influence of long-term declining or changing groundwater levels.

One of the most reliable modern methods for determining groundwater recharge is the use of integrated water balance models such as MIKE SHE. These models represent all processes of the hydrological cycle within a single framework and calculate them based on physical laws. In contrast to conventional approaches, the exchange between the unsaturated and saturated zones-and thus the groundwater response to recharge-is explicitly included in both simulation and calibration.

POSTER 125

Innovation in the NCEA - Autosalt flow instrument

Dan Jackson, Hydrometry Specialist, Environment Agency

As part of the Natural Capital Ecosystem Assessment, I investigated ways to improve data quality at river flow stations within the project sub network, whilst exploring new technologies and innovation. Two sites—Low Houses (North Yorkshire) and Moorhouse (Upper Teesdale)—show high uncertainty in mid to high flows due to out of bank flow, siltation upstream of weirs, and non modular flow conditions.

Both stations are in remote upland catchments with rapid changing river levels, making it difficult for Hydrometry officers to capture high flow gaugings needed to validate ratings. To address this, two Autosalt instruments were installed in September 2024. Manufactured by Fathom Scientific, (Vancouver) the systems use an automated salt dilution method to provide remote spot flow gaugings—technology previously untested by the Environment Agency.

Since installation, spot gaugings have increased by 150%, filling key data gaps across the flow range. The highest flows on record have been measured at both sites, enabling new investigation of out of bank flow. The trial is assessing operational performance, reliability, and data quality to determine suitability for wider national use. If successful, the Autosalt would add to the Environment Agencies flow measurement capabilities, supporting improved validation and data analysis within our hydrometric network.

This presentation would look at some of the findings of the trial, highlighting the importance of quality field data, innovation and collaboration within the Hydrometric community.

POSTER 126

What Insights Do We Gain From Applying Deep-Learning to a Large-Sample Groundwater Level Dataset Across England?

Qidong Fang, Shams Rahman, Thorsten Wagener, Francesca Pianosi

Groundwater provides around 30% of public water supply in England and more than 75% in the densely populated, water-stressed Southeast. With growing demand and the prospect of more frequent and severe droughts, understanding groundwater behaviour across space and time is essential for sustainable water management. However, groundwater level observations are commonly sparse and difficult to access.

Recently, the Environment Agency (EA) of England and Wales released an open-access dataset of groundwater level records across England, which include more than 3400 wells with more than 200,000 daily and 200 million sub-daily sampling observations, for the period from the late 19th century to the present. Meanwhile, rapid advances in AI have highlighted Deep Learning as a powerful tool to learn complex, nonlinear relationships from big data. These offer an unprecedented opportunity to analyse the EA dataset and gain insights on the spatial and temporal variability of groundwater levels across England.

In this study, we report results of such Deep Learning (DL) analysis. Specifically, we investigate:

1) When and where did the groundwater levels exhibit long-term trends and what can be the potential drivers for these trends?

2) How well can DL (or DL blended) models simulate the groundwater variability across England?

3) What do we learn from these DL applications that may be useful for learning about processes, data, mechanistic modelling?

POSTER 129

Can Direct Rainfall Hydraulic Models Represent Hydrological Processes in Floods? Lessons Learnt from UK Applications

John Dudley

Direct rainfall in 2D hydraulic models and integrated catchment models are now widely applied to support flood risk management. This has been driven by improved availability of digital terrain data, rainfall products, modelling platforms, and automated workflows. Direct rainfall modelling by consultants, regulators, and local authorities continues to expand. This study presents lessons learnt from applying rainfall directly to 2D hydraulic models across a range of UK catchments.

The analysis draws on flood model applications in catchments with contrasting characteristics, including steep and gently sloping systems, lowland environments, and urban and rural settings. Comparisons show how context, scale, and resolution are important. Model performance and sensitivity vary with representation of the 2D surface and data resolution. Increasing data volume and model complexity can improve performance, however these improvements are not universal and remain highly context dependent.

Important findings include that 2D models may provide partial representations of flood hydrological processes, however, 2D modelling offers flexible and practical simulation of runoff and flooding. Overall 2D models can struggle to represent subsurface processes, antecedent conditions, and catchment response. Therefore the increasingly detailed digital datasets do not automatically lead to an improved representation of hydrological processes.

These findings highlight the need for critical review of digital data inputs, consistent modelling standards, and communication of model uncertainty.

POSTER 131

Towards improved flood early-warning coverage in England using machine learning

Anna Lo Jacomo, Katie Pearson, Adam Parkes

The Environment Agency (EA) in England faces a major gap in flood early-warning coverage: around 220 at-risk catchments remain unmodelled. While conceptual rainfall–runoff and hydraulic models are used elsewhere, these gaps leave communities exposed, an issue likely to worsen under climate-driven increases in extreme weather.

In collaboration between Digital & Data and Water & Environment teams, Jacobs benchmarked machine learning (ML) models against the EA's conceptual rainfall–runoff models (Probability Distributed Models, PDMs).

Performance was assessed across eight diverse catchments, testing varying data lengths, configurations, and hydrological inputs.

Open-source LSTM models reproduced catchment dynamics using as little as two years of 15-minute data, with training times of ~1 hour on GPU (~5 hours on CPU). ML performance on NSE and KGE was comparable to PDMs for flow prediction, and superior for water level estimation (critical for flood forecasting) compared to PDMs combined with rating curves. However, PDMs remained more reliable for peak flow representation, based on threshold-crossing metrics (POD, FAR). Across all sites, input data quality was the dominant driver of performance, outweighing factors such as training length (2–12 years) or evapotranspiration inputs.

These results position ML as a practical complement to existing forecasting systems, particularly for overcoming rating curve limitations and rapidly extending coverage to unmodelled catchments.

POSTER 135

Persistent Drought & Water Supply System Risk in a Changing Climate

Cerith Morgan, Stephen Blenkinsop, Stephen Birkinshaw, Manuel Herrera, Jaime Amezaga, Beverley Pixton, Richard Blackwell

Droughts present a significant risk to society and public water supply systems in England and Wales. To address this, UK water companies are required to meet 1 in 500-year drought resilience standards by 2040, and a global temperature increase of 2C by 2050. This planning process uses stochastic weather generation (SWG) to generate time series for use in hydrological and water resources models to evaluate system resilience. Subsequently, using climate change uplift factors derived from the UKCP18. However, the use of change factors offers a limited representation of climate change which underestimates its true impact on water resources. This necessitates the development and application of other methods, incorporating more detailed changes to weather variability which could drive more frequent water shortages in a future climate.

My research involves developing an SWG which can recreate drought persistence with the capability of incorporating climate change impacts such as changes to seasonality, dry spell duration and drought occurrence frequency. Combining this with different methods, to account for low frequency climate variability.

Future work will use the outputs of this new SWG and climate projections in hydrological and water resources models to characterise the risk to water resources systems within the UK.

Ultimately, the finds of this research will enhance water resources planning in the UK by enabling more comprehensive simulations of drought. Additionally, helping to inform where alternatives methods could increase the robustness of water resources planning.

POSTER 137

Understanding fluvial floods in groundwater-dominated catchments

Helen Harfoot, Justin Sheffield, Christopher Jackson and Sean Longfield

Fluvial flooding has been assessed as one of the greatest natural and environmental hazards in the England with 2.4 million properties identified by the Environment Agency as currently at risk of flooding from rivers or sea. Encapsulated within this figure is flooding within groundwater-dominated catchments, where stored groundwater contributes to fluvial flooding. The presence of an unsaturated zone acts to attenuate surface water runoff so these catchments historically experience fewer fluvial flood events, but due to the delayed and persistent contribution of groundwater when flooding does occur it can be prolonged and unexpectedly severe. This poster will present research being undertaken to explore approaches to differentiate sources of fluvial flows and characteristics of these floods to understand how groundwater contributes to fluvial floods in catchments underlain by permeable geologies and how this evidence might be used to improve estimates of flood risk in England and Wales.

POSTER 138

The 1976 Drought Revisited: 50 years on, does it remain the benchmark?

Steve Turner, Rachael Armitage, Lucy Barker, Jamie Hannaford + NHMP Team

Fifty years on, the 1976 drought remains one of the most significant hydrological events in the UK, prompting profound and lasting changes in water management, policy, and public awareness. Contemporary droughts are

routinely framed in relation to 1976 in media coverage, with headlines such as “Taps ran dry in 1976 – could we be heading for a drought just as bad?” (Sky News, 11 July 2025), and with the drought’s sudden transition to flooding, it still serves as a benchmark.

Using observed river flow records from the National River Flow Archive, this study, undertaken by the National Hydrological Monitoring Programme, places the 1976 drought within its long-term historical context and evaluates its severity relative to both earlier and more recent UK droughts. We assess transitions from drought to flood periods, allowing comparison of how the recovery from 1976 differs from that observed during more contemporary events. Low flow trend analyses are also conducted across the UK, with comparison against the UK Benchmark Network of near-natural catchments. This approach helps to disentangle the influences of climate variability and change from those of human modification, regulation, and water management practices.

By revisiting the 1976 drought using consistent observational metrics, this analysis provides a robust benchmark for interpreting present day drought events and associated media narratives. It also offers insights into how evolving climate pressures and water management strategies may shape future drought risk and hydrological resilience in the UK.

POSTER 140

Using natural tracers to investigate and model catchment scale natural flood management: insights from the Eddleston Water project

Dr Leo Peskett, Ms Sarah Collins, Dr Andrew Black, Prof Alan MacDonald, Prof Kate Heal, Dr Chris Jackson, Dr Andy Young

Natural flood management (NFM) is increasingly prominent in flood risk policy, yet evidence of effectiveness and robust impact forecasting methods remain limited. Traditionally, links between land management, runoff and water storage have been inferred from rainfall-runoff responses and tested using hydrological models calibrated to streamflow. This approach carries high uncertainty, as discharge data alone provide only a partial view of catchment behaviour. Tracer-based approaches tracking water movement through catchments have potential to address this challenge.

We present insights from a research programme in the Eddleston NFM catchment, one of the UK’s longest running NFM pilot sites. Using combined hydrometric, isotopic (^{2}H, ^{18}O) and geochemical data from long term, nested catchment monitoring, we examined controls on water storage and storm runoff across event to annual timescales. Results show large variability in dynamic storage and the dominance of soil hydraulic properties over land cover in controlling runoff and subsurface storage.

We also calibrated a hydrological model using streamflow and groundwater contributions estimated from acid neutralising capacity (ANC). This tracer revealed major differences in surface-subsurface flow partitioning hidden when using discharge alone, reducing predictive uncertainty by up to 39% for peak flows and ~50% for low flows under a woodland planting scenario. These findings highlight the value of these approaches for improving process based evaluation of, and reducing uncertainty in, catchment scale water management.

POSTER 141

Tracking hydrological response to woodland creation in an upland catchment.

Robyn Wrigley, Felicity Monger, Dominick Spracklen

Flood risk is increasing in parts of the UK as the climate changes. Woodland creation is often suggested as a way to help reduce downstream flooding, but there is still limited real-world data showing how effective it is, especially in the early years after planting.

This study focuses on the Woodland Trust’s Snaizeholme Estate in the Yorkshire Dales, an upland headwater catchment transitioning from sheep-grazed grassland to a woodland-grassland mosaic. It provides a rare opportunity to track how stream flow responds over time, rather than relying on space-for-time comparisons. A network of in-stream pressure loggers, an Environment Agency gauge at the catchment outlet, and on-site weather stations have been collecting continuous rainfall and discharge data since 2024. Future work will include measurements of soil permeability and overland flow to better understand how the site changes as woodland develops.

Early results show that, with trees only planted in the last three years, the catchment still responds quickly to heavy rainfall, producing rapid rises in flow and high peaks. However, modelling using TOPMODEL indicates that

the current woodland creation design, resulting in around 28% woodland cover, could reduce peak flows from large storm events by approximately 5%.

This work provides a valuable long-term case study of how an upland catchment responds to woodland creation. It will improve understanding of how flood risk may change over time and help refine hydrological models to better represent conditions during the early stages of woodland establishment.

POSTER 143

Assessing the Impact of Wild Camping on Water Quality in the English Lake District

Christopher Stringer, Graham Rush, Martin Pritchard, Jenna Sutherland, Anthony Smith, Sebastian Budniak, Joseph Russell

Wild camping appears to be of increasing popularity in English upland environments, despite it being prohibited in most parts of England. Whilst wild camping provides well-documented wellbeing benefits, growing visitor pressure has raised concerns regarding its sustainability and governance. One concern is that human waste may pollute sensitive upland freshwater systems. In this poster, we present results from a pilot study investigating water quality at five upland tarns in the English Lake District. We analysed 18 water samples from across these tarns for faecal indicator organisms (E.coli and Enterococci) from all sources using membrane filtration. This was supplemented by environment DNA analysis using PCR to identify the presence of human faecal matter (as indicated by the HF183 indicator). 16 out of the 18 samples collected scored as "excellent" when compared against DEFRA's water quality classification, with two samples classified as "poor". These two samples were both taken from Easedale Tarn, which was associated with relatively high numbers of campers during our field visit. Furthermore, seven of our samples showed the presence of human faecal matter (HF183). This indicates that wild camping may have an impact on water quality, but that crucially further study is needed to investigate this relationship. Further research should aim to conduct longer term monitoring and to make use of quantitative PCR approaches to estimate the specific role human faecal matter plays in the contamination of freshwater when compared to other sources (e.g. sheep and wildlife).

POSTER 144

Combining Citizen Science with Environment Agency Data to Monitor Intermittent Streams

Mike Summers, Ben Ball, Paula Dobin, Rob Grew, Kelly Haynes

The Environment Agency's Flow Detectors Project explores how citizen scientists can help monitor intermittent streams - ecologically important yet under monitored systems vulnerable to climate change and abstraction pressures. Traditional hydrometric networks struggle to capture the dynamic wetting and drying behaviour of these streams, making citizen science approaches a valuable complementary data source.

Through the project, we are promoting the wider use of two existing citizen science mobile phone apps, CrowdWater and DRYRivERS, and seeking feedback on using the apps to monitor intermittent streams. In this poster, we present recent work exploring how this citizen science data can be integrated with Environment Agency observations, and the relative scale (both spatial and temporal) of different available datasets.

There are a wide range of user needs for more intermittent stream data (including drought management, flood forecasting, local catchment investigations and hydroecology), across a wide range of groups and organisations. Could an integrated dataset help to better meet these in the future?

This work is part of the Environment Agency's contribution to Defra's Natural Capital and Ecosystem Assessment (NCEA) Programme and its own Supporting Citizen Science initiative.

POSTER 150

Petrichor: A Python Workflow for Processing Cosmic-Ray Neutron Sensing Data into Site-Scale Soil Moisture

Ming Guo

Soil moisture is a key state variable of the terrestrial water, energy, and carbon cycles, exerting strong controls on evapotranspiration, runoff generation, groundwater recharge, crop productivity, and land–atmosphere feedbacks. Reliable measurements of soil moisture are therefore essential for hydrological modelling, drought monitoring, irrigation management, and climate research. However, conventional point-scale sensors capture only a small support volume, while satellite retrievals operate at coarse resolutions that are often incompatible with field-scale processes. Cosmic-ray neutron sensing (CRNS) has emerged over the past decade as a robust, non-invasive technique that bridges this observational gap, providing area-averaged soil moisture estimates over a footprint of several hectares and depths of tens of centimetres. Driven by its field-scale representativeness and low

maintenance requirements, CRNS has seen rapid adoption worldwide, with national and international networks (e.g., COSMOS-US, COSMOS-UK, COSMOS-Europe, and CosmOz) now operating hundreds of stations. Converting raw neutron counts into reliable soil moisture estimates, however, requires a chain of processing steps that correct for atmospheric, environmental, and site-specific influences, and the lack of standardised, transparent tooling remains a barrier to consistent CRNS data use.

To address this, we have developed Petrichor, a Python workflow for converting cosmic-ray neutron counts into site-scale soil moisture products. The tool integrates raw-data preprocessing, multi-timescale aggregation, and all necessary signal corrections for atmospheric pressure, humidity, incoming high-energy neutron intensity driven by solar activity, and vegetation. Petrichor also calibrates any cosmic-ray neutron sensor using site-specific soil sampling data to derive N0, and applies quality control and uncertainty propagation throughout the processing chain. It automatically generates pre-defined visualisations and summaries, including daily, monthly, and yearly statistics, metadata records, and diagnostic figures such as multiscale soil-moisture plots. Petrichor is intended to provide a transparent, reproducible, and practical framework for processing CRNS data in hydrological studies. In this work, we demonstrate its capabilities by applying it to sites from distinct hydroclimates, showcasing how Petrichor can be used to process and evaluate soil moisture dynamics from cosmic-ray neutron sensing technology.