Peter Wolf Early Career Symposium 2022: Hydrological Innovation for the Climate Emergency

University of Strathclyde & the British Hydrological Society

20 – 21 September 2022

The 2022 British Hydrological Society Peter Wolf Early Career Hydrologist's Symposium will be hosted by the Centre for Water, Environment, Sustainability & Public Health at the University of Strathclyde in Glasgow from 20 to 21 September 2022. The theme of the 2022 Peter Wolf Symposium is Hydrological Innovation for the Climate Emergency. It will be a valuable opportunity for early career hydrologists across the country to come together and share their recent work on all areas of hydrology and how it relates to the climate emergency. Please visit the symposium website for full details.

Organising committee: Christopher J. White (University of Strathclyde), Michael Cranston (Scottish Environment Protection Agency), Lucy Barker (UKCEH) and Scott McGrane (University of Strathclyde)

Our partners

The Peter Wolf Symposium is kindly supported by Scotland's Centre of Expertise for Waters (CREW). CREW is funded by the Scottish Government and is at the forefront of science-policy knowledge brokering, ensuring the right information gets to the right people in the right way and at the right time. CREW provides *actionable recommendations* gathered through evidence-based research, synthesis, analysis and expert knowledge to support water-related policy, regulatory and industry activities of Scottish Government and its delivery partners such as the Scottish Environment Protection Agency (SEPA), Scottish Water, and NatureScot. CREW work closely with Scottish Higher Education Institutes and Research Institutes, our sister Centres of Expertise, SEFARI and the wider Hydro Nation family, including the Hydro Nation International Centre, Hydro Nation Water Innovation Service, Hydro Nation Chair, the Hydro Nation Scholars Programme and CREW International.

Full programme

Day 1: Tuesday 20 September 2022	
Day 1 morning session	
09:30 – 10:00 Tea/coffee and registration	
10:00 – 10:15 Symposium welcome	Christopher White, University of Strathclyde
10:15 – 10:25 Address from the President of the British Hydrological Society	Hayley Fowler, Newcastle University / British Hydrological Society
10:25 – 10:30 Welcome from our partner, Scotland's Centre of Expertise for Waters (CREW)	Rachel Helliwell, CREW
10:30 – 11:00 Icebreaker (incl. break)	
Oral presentation session 1: Flood risk management	
11:00 – 11: 15 Are flood risk assessments up to date? Is Scotland prepared for floods under climate change? A review of techniques used in Scotland.	Felipe Fileni, Newcastle University (O.3)
11:15 – 11:30 Probabilistic framework for robust predictions of extreme wave characteristics	Euan Macdonald, University of Strathclyde (O.12)
11:30 – 11:45 Small Catchment flows – Investigating the FEH equation for adjusting drainage path length (DPLBAR)	Rozy Shepherd, JBA Consulting (O.20)
11:45 – 12:00 A framework to assess the impact of flooding on the release of microplastics from waste management facilities	Marta Ponti, University of Strathclyde (O.17)
12:00 – 12:15 Probabilistic assessment of riverine masonry arch bridges: scour fragility of arches in a changing climate.	Giuseppe Degan Di Dieco, University of Bristol (O.2)
12:15 – 12:30 Evaluation of image velocimetry techniques to monitor river flow properties at flood-critical bridges	Eleonora Perugini, University of Strathclyde (O.16)
12:30 – 12:45 Evaluating the impact of urban wetlands as natural-based solutions at the catchment scale	Fangjun Peng, Imperial College London (O.15)
12:45 – 13:30 Lunch	
Day 1 afternoon session	
13:30 – 14:00 Keynote: For those on the front line of the climate emergency: How you can help SEPA help them	Vincent Fitzsimons, Scottish Environment Protection Agency
Oral presentation session 2: Water resources	
14:00 – 14:15 Physical climate storylines of UK droughts	Wilson Chan, University of Reading (O.1)
14:15 – 14:30 Resilience of Private Water Supplies in North-East Scotland	Padraig Gilhooley, Mott MacDonald (O.4)
14:30 – 14:45 Multi-scale water resources planning in England and Wales	Ali Leonard, Newcastle University (O.11)

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14:45 – 15:00 Citizen-derived data as an important tool in tackling the climate emergency. Case Study: water management in Malawi	Donald Robertson, University of Strathclyde (O.18)
15:00 – 15:15 Development of a rainfall-runoff model based drought forecasting tool applied in the Anglian region	Ilona Szabo, Mott MacDonald (O.21)
Flood hydrology skills survey session	
15:15 – 16:45 Flood hydrology improvements programme skills survey session (incl. break at the start)	Annie Ockelford, Environment Agency
Poster session	
16:45 – 18:15 Poster session (see page 4 for a list of posters)	
Symposium evening dinner/social event	
~18:30 – late Symposium dinner at The Platform (253 Argyle Street, Glasgow, G2 8DL; ~15 mins walk from Strathclyde)	

Day 2: Wednesday 21 September 2022	
Day 2 morning session	
09:00 – 09:15 Tea/coffee and welcome to day 2	Christopher White, University of Strathclyde
09:15 – 09:45 Keynote: Hydrological research innovation for the climate emergency	Lindsay Beevers, University of Edinburgh
Oral presentation session 3: Reservoirs and hydropower	
09:45 – 10:00 An updated assessment for run of river hydropower potential in the UK	Diana Golgojan, University of Strathclyde (O.5)
10:00 – 10:15 The existing hydropower use of the United Kingdom	Claire Kennedy, University of Strathclyde (O.9)
10:15 – 10:30 The Black Drin basin: A panoply of hydrological modelling challenges in the Balkans	Kieran Murnane, Chartered Institute of Water and Environmental Management (CIWEM) (O.13)
10:30 – 11:00 Break	
Oral presentation session 4: Hydrological and environmental impacts of climate change	
11:00 – 11:15 The Impact of Leys and Sheep Grazing on Soil Structure and Hydrological Functioning	Emily Howes, Heriot-Watt University (O.7)
11:15 – 11:30 An integrated hydrodynamic model for flash flood and debris flow simulations	Xilin Xia, University of Birmingham (O.22)
11:30 – 11:45 ROBIN - A Reference Observatory of Basins for INternational hydrological climate change detection	Alannah Killeen, UK Centre for Ecology & Hydrology (UKCEH) (O.10)
11:45 – 12:00 Assessment of impacts of papyrus dominated wetlands on catchment hydrology: case of Mpologoma catchment in Uganda	Alem Oyarmoi, Newcastle University (O.14)
Day 2 afternoon session	

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12:00 – 12:30 Keynote: Glasgow's Smart Canal – repurposing canals as ready-made solutions	Peter Robinson, Scottish Canals
12:30 – 13:00 Lunch and winners/runners-up of the best presentations and posters announced!	
Site visit	
13:00 – 16:00 Site visit to the Glasgow Smart Canal (~30 mins walk from Strathclyde)	Peter Robinson, Scottish Canals
16:00 – 17:00 Return to the University; wrap-up and symposium close	Christopher White, University of Strathclyde

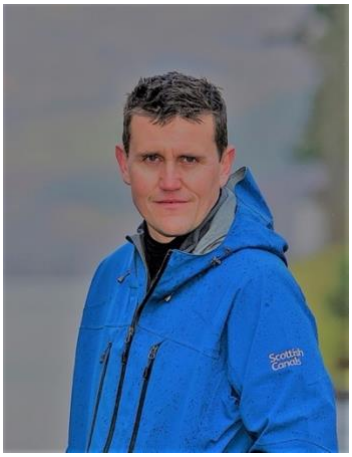
Posters (day 1)

Poster session – day 1 (16:45 – 18:15)	
Turning the tide on limited coastal data: Digitising historic tidal ledgers from the River Clyde, Glasgow	Nicola Ellis, SEPA (P.1)
Identifying promising conjunctive use strategies in the UK	Zuzanna Janas, University of Bristol (P.2)
A combined empirical and hydrologic model concept for blue/green water-based accounting framework for assessment of water security in data-sparse regions	Ibrahim Lawal, University of Strathclyde (P.3)
Quantifying the effectiveness of Natural Flood Management interventions in a heavily modified lowland catchment	Copper Lewis, Heriot-Watt University (P.4)
May a statistical interpolated method improve ERA5 rainfall accuracy? A case study in the region with distinct topographical features	Yuexiao Liu, University of Bristol (P.5)
Baseflow and Hydrograph Comparisons in a Data-Sparse Rewilding Catchment	Michael MacDonald, University of Dundee (P.6)
Quantifying the Effectiveness of Natural Flood Management Measures for Reducing Flood Risk: Optimizing for Scale and Location.	Hazhan Majeed, Heriot-Watt University (P.7)
Groundwater Resilience under Extreme Drought	Eleyna McGrady, Newcastle University (P.8)
Developing a Bayesian Network model to account for catchment-scale faecal indicator organism losses from septic tank systems	Chisha Mzyece, University of Stirling (P.9)
Quantifying abstraction impacts in the Water Resources West region	Anna-Louise Prince, Stantec (P.10)
Large-scale detection of reservoir impacts through hydrological signatures	Saskia Salwey, University of Bristol (P.11)
Developing precipitation datasets for mountain regions in a changing climate	Keith Shotton, Newcastle University (P.12)
Assessing the Impacts of Climate Change Using Hydrological Modelling for the River Dee Catchment, Northeast Scotland	Chenyuan Wang, University College London (P.13)

Keynote presentations

Name	**Prof Hayley Fowler, Newcastle University**
Keynote title	President of the British Hydrological Society's opening address
Bio	Prof Hayley Fowler is the President of the British Hydrological Society and Professor of Climate Change Impacts in the Water Resource Systems Engineering Group in the School of Engineering at Newcastle University. She is a hydroclimatologist with >15 years of experience in analysing the impacts of climate change and variability on hydrological systems and has published more than 90 ISI-cited articles since 2000. She held a NERC Postdoctoral Fellowship (2006-10) examining the links between atmospheric circulation patterns, extreme rainfall and flooding, was awarded a Philip Leverhulme Prize (2011), Royal Society Wolfson Research Merit Award (2014) and made a Fellow of the American Geophysical Union in 2018. She specialises in the analysis of the impacts of climate change and variability on hydrological and water resource systems, examining recent trends in extremes and future projections and their impacts on flood and drought risks. She has been instrumental bridging the gap between modellers and users of climate information.

Name	**Peter Robinson, Scottish Canals**
Keynote title	Glasgow's Smart Canal – repurposing canals as ready-made solutions
Bio	Peter Robinson is Head of Engineering for Scottish Canals. With responsibility for over 4,100 very unique assets across Scotland he has a unique insight into the history of Scottish Engineering innovation, current challenges and opportunities and the future challenges of limiting climate change the impacts of it. A Chartered Engineer and Fellow of the Institution of Civil Engineers. His career has included working In Flood Risk Management for over 20 years, delivering schemes across the Scotland, the UK and Middle East. He led a team designing a new city for Saudi Arabia before joining Scottish Canals. He started his career working as a designer on the Millennium Link, created



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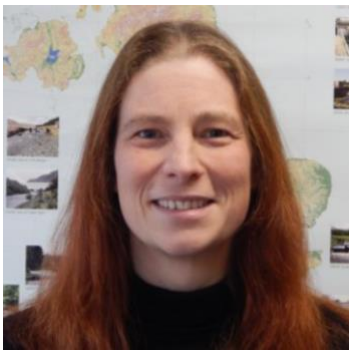
	Glasgow's Smart Canal system and he and his wife also spent 2 years sailing round the world, including passing through the Panama Canal - his first taste of canal engineering!	

Name	**Vincent Fitzsimons, Scottish Environment Protection Agency**	
Keynote title	For those on the front line of the climate emergency: How you can help SEPA help them	
Bio	Vincent Fitzsimons is head of SEPA's hydrology and flooding teams. The teams deliver SEPA's flooding service and also provide specialist advice to SEPA's regulatory service. Vincent has been a manager in SEPA for 15 years. Before that he worked as a hydrogeologist for 15 years in Ireland and Scotland, focussing on preventing and remediating groundwater contamination.	

Name	**Prof Lindsay Beevers, University of Edinburgh**	
Keynote title	Hydrological research innovation for the climate emergency	
Bio	Prof Lindsay Beevers joined the University of Edinburgh in January 2022 as the Chair in Environmental Engineering. She is a Civil Engineer with over 20 years' experience and is author to over 50 peer reviewed journal papers in high impact journals, and 6 book chapters. She has worked both in industry as an engineer (Jacobs 2003-2007) as well as in academia. From 2007-2010 she worked in the Netherlands at UNESCO-IHE Institute for Water Education (now known as IHE Delft) where she was involved in education, capacity building and research projects in river systems across the world. Most of her work was focussed in Africa on the Nile and the Zambezi basins, and Asia on the Mekong river.	

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Flood Hydrology Improvements Programme skills survey session (day 1)

Environment Agency's Flood Hydrology Improvements Programme	
The Environment Agency's Flood Hydrology Improvements Programme (FHIP) aims to deliver a change in the way we use hydrology to forecast and plan for flooding, through supporting actions laid out in the UK's 25 Year Flood Hydrology Roadmap. As part of this we will shortly be launching a UK wide skills survey of the hydrology community which aims to understand the background, skills, attitudes and activities of that community. During the Peter Wolf Symposium 2022, we are particularly keen to hear the thoughts and opinions of early career hydrologists who represent the future of the discipline. In this interactive session, we will identify what hydrology skills you already have, understand how you would like to develop new skills in the future and discuss your thoughts on the future of hydrology. Your thoughts will help up inform the skills survey as well as helping to inform the longer-term UK Flood Hydrology Roadmap.	Flood Hydrology Improvements Programme

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Site visit (day 2)

Glasgow Smart Canal	Scottish Canals
The Scottish Canals Glasgow Smart Canal is an award-winning drainage system in Glasgow that combines modern technology with an 18th century canal to unlock regeneration across Scotland's Central belt. The North Glasgow Integrated Water Management System, known as the 'Glasgow Smart Canal', uses pioneering sustainable drainage principles to provide flood risk reduction, water quality management and habitat improvement for local communities. Believed to be the first of its kind in Europe, it unlocks 110 hectares of land for investment, regeneration and development. It paves the way for more than 3,000 new homes to be built, while avoiding over 30,000 tonnes of operational CO2e. With North Glasgow's sewer systems reaching capacity, new solutions for surface water management were needed. Engineering firm, AECOM, developed the £17 million smart canal concept on behalf of Scottish Canals, Glasgow City Council and Scottish Water within the Metropolitan Glasgow Strategic Drainage Partnership to tackle this challenge. Funding for the scheme was provided by to Glasgow City Region City Deal and two ERDF programmes (Green Infrastructure Fund & Scotland's 8th City – the Smart City). Meteorological forecasting data and sensors give advanced warning of heavy rainfall and automatically trigger a lowering of the water in the Forth & Clyde Canal, a scheduled ancient monument. By enabling real-time operational management, the canal will become an intelligent water management system proactively providing surface water storage when required. You can watch a video here: https://www.youtube.com/watch?v=Qz6Sk3Z2Xs4 Please note: The Glasgow Smart Canal is ~30 mins walk from the University of Strathclyde campus. We will walk as a group to the site, and return to the campus afterwards. The site and the walking route to it is serviced by footpaths. Please bring comfortable walking shoes (walking boots are not needed, however, waterproof shoes are advised), and please bring appropriate clothing in case of inclement weather – this is Glasgow after all! Please get in touch if you have any questions, and **please inform us via peterwolf2022-conf@strath.ac.uk if you have any disabilities and/or may require assistance regarding the site visit before the symposium starts.**	

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A-Z list of submitted abstracts (oral presentations and posters)

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Presenter	**Wilson Chan**, PhD Candidate, Department of Meteorology, University of Reading (wilson.chan@pgr.reading.ac.uk)
Co-author(s)	**Theodore Shepherd**, Department of Meteorology, University of Reading; **Nigel Arnell**, Department of Meteorology, University of Reading; **Katie Facer-Childs**, UK Centre for Ecology and Hydrology; **Geoff Darch**, Anglian Water; **Karin van der Wiel**, Royal Netherlands Meteorological Institute (KNMI)
Title	Physical climate storylines of UK droughts
Abstract	The frequency and severity of hydrological droughts in the UK are projected to increase with climate change. Studies of the impacts of climate change on UK river flows generally followed "top-down" GCM-driven or probabilistic approaches characterized by the cascade of uncertainty. "Bottom-up" approaches such as the scenario-neutral and storyline approach emerged as ways to complement existing projections to better understand the plausible pathways leading to high-impact events. Here, we demonstrate the creation of different types of physical climate storylines of UK droughts. First, event storylines based on individual events imagine downward counterfactuals from a wide range of plausible changes to the event's causal factors. Event storylines based on the 2010-12 drought showed how the drought could have matched or exceeded conditions observed in past severe droughts given changes to its preconditions, temporal drought sequence and climate change, especially highlighting vulnerability to a plausible "three dry winter" situation. Second, storylines can also be explored within probabilistic approaches. We employ large ensemble climate model output to estimate the likelihood of unprecedented droughts and searched within the large ensemble to create storylines resembling specific conditions that have led to past droughts and are relevant for water resources planning. This includes droughts characterized by 1) dry autumns followed by dry winters (relevant for slow-responding catchments and 2) dry springs followed by dry summers (relevant for fast responding catchments). Storylines constructed based on observed events and conditioned on large ensemble simulations can be used to stress test hydrological systems against unrealized droughts and inform decision-making.

Presenter	**Giuseppe Degan Di Dieco**, PhD Candidate, Department of Civil Engineering, University of Bristol (giuseppe.degandidieco@bristol.ac.uk)
Co-author(s)	**Mark Hobbs**, The Alan Turing Institute, Data-Centric Engineering Programme; **Andre Barbosa**, Oregon State University, School of Civil and Construction Engineering; **Maria Pregnolato**, University of Bristol, Department of Civil Engineering
Title	Probabilistic assessment of riverine masonry arch bridges: scour fragility of arches in a changing climate
Abstract	The frequency and intensity of hydrological hazards has increased due to climate change, and they are expected to increase further. As a result, worldwide riverine bridges have suffered damage or completely failed due to floods. It is evident that current bridge assessment cannot cope with ever-changing scenarios. Therefore, infrastructure owners are adopting probabilistic models to estimate likely damages to their assets via fragility curves. Fragility curves are developed for bridge classes in each portfolio. However, flood-hazards fragility curves are lacking for main riverine bridge classes. This study developed a fragility curve to account for local scour effects on arches of masonry bridges, which represent the main bridge type in the UK. A typical masonry bridge, destroyed by 2015 winter floods in Yorkshire, is used as a case study. The structural analysis was carried out considering indications of the UK Design Manual for Road and Bridges. Uncertainties in masonry's unit weight and resistance were considered using Monte Carlo simulations. Bridge damage data was fitted either with lognormal fragility or logit functions. It was found that the lognormal fragility function better fits the data than the logit function. However, the logit function performs well in distinguishing between damage/no damage cases given an attribute (such as span length), whereas this is not possible with a lognormal function. Therefore, the logit function can be used to identify bridge classes by changing attributes. Future research opportunities include developing fragility curves for other bridge's components which underpin the joint probability distribution of a bridge's structural failure.

Presenter	**Nicola Ellis**, Scientist, Scottish Environment Protection Agency (SEPA) (nicola.ellis@sepa.org.uk)
Title	Turning the tide on limited coastal data: Digitising historic tidal ledgers from the River Clyde, Glasgow
Abstract	Extensive, high temporal resolution data is the ultimate input for any flood model. Many coastal models are restricted by limited tidal records. This project aims to provide more data for the Clyde estuary, Glasgow and understand future flood risk through digitising historic tidal records over thirteen locations dating as far back as 1840. The British Oceanographic Data Centre currently holds over 300 volumes of stilling well tidal charts and handwritten ledgers which contain valuable tidal data alongside records of weather conditions. The ledgers have been professionally scanned and stored as tiff files. With a wealth of potential data available, avenues such as citizen science will be used to interpret ledgers, with the added advantage of engaging the public in climate change issues. The resulting tidal data will have numerous potential benefits, such as being used to better quantify tidal conditions through history in the Clyde estuary to understand potential future climate change impacts in Glasgow. The data will also aid calibrating models to support adaptation decisions.

Presenter	**Felipe Fileni**, PhD Candidate, Newcastle University (F.De-Mendonca-Fileni2@newcastle.ac.uk)
Co-author(s)	**Fiona McLay**, SEPA; **Elizabeth Lewis**, Newcastle University; **Hayley Fowler**, Newcastle University
Title	Are flood risk assessments up to date? Is Scotland prepared for floods under climate change? A review of techniques used in Scotland
Abstract	Are flood risk assessments in Scotland up to date? We aim to contextualise the techniques and requirements of flood risk assessments (FRAs) in Scotland; as well as giving an overview of how they are applied in practice. The Flood Estimation Handbook (FEH) has undergone numerous updates aiming to improve its methods and techniques. Nevertheless, these methodologies present a degree of imprecision. Notably, the majority of FRAs in Scotland are performed for small (<100km2) ungauged catchments, which reduces the number of FEH methods available. For instance, there is only one rainfall/runoff modelling technique available in the handbook; often an updated (ReFH2) and outdated (FEH rainfall/runoff) version of the same technique are used for comparison. Furthermore, due to lack of smaller catchments' data for calibration in the FEH and its updates, the techniques show their lowest performance in these catchments. Finally, there is compelling evidence that smaller catchments will be the most affected by climate change. Scotland presents specific guidelines to account for climate change. There is room for improvements in climate change guidance, especially in the definition of small catchments. We conclude that flood risk assessments are not up to date in Scotland. A wide variety of modelling techniques, such as using physically based models, continuous modelling or multivariate approaches, could be implemented into FRAs. These would be especially valuable for smaller catchments and could help decision-makers and industry to make better informed decisions for both current and future scenarios.

Presenter	**Padraig Gilhooley**, Graduate Hydrologist, Mott MacDonald (padraig.gilhooley@mottmac.com)
Title	Resilience of Private Water Supplies in North-East Scotland
Abstract	A private water supply (PWS) refers to water not sourced from the mains distribution network, but from a local surface or groundwater source. In Scotland, approximately 22,000 PWS serve around 200,000 people for domestic and commercial water use. Within Aberdeenshire, Moray and Angus circa 40,000 people, get their water from around 9,000 PWS. During dry periods, properties in these areas have required support due to shortage of supply from PWS, with around 300 properties requesting assistance during 2018 and 2020. The Scottish Government's objective is to enable and sustain inclusive economic growth and is committed to delivering the United Nation's Sustainable Development Goal 6. In support of this commitment, the m2 joint venture (Mott MacDonald/Stantec) was commissioned by Scottish Water to develop a strategic appraisal of options to provide long term reliable water supplies to properties in Aberdeenshire, Moray and Angus in the face of climate change. A new methodology was produced to understand the vulnerability of PWS at property level and/or source location using existing surface water and groundwater data. From analysis of their locations with respect to existing SW mains and other PWS, properties were assigned to proximity groups. Indicative solutions were identified for the improvement of PWS within the region and their suitability and benefits assessed for each of the proximity groups. The presentation will cover the application of the methodology, and an overview of the project findings, with a focus on PWS vulnerability.

Presenter	**Ana-Diana Golgojan**, PhD Candidate, Department of Civil and Environmental Engineering, University of Strathclyde (anadiana.boca@strath.ac.uk)
Co-author(s)	**Christopher White**, University of Strathclyde; **Douglas Bertram**, University of Strathclyde
Title	An updated assessment for run of river hydropower potential in the UK
Abstract	Worldwide, hydropower is the most used renewable energy type comprising approximatively 16% of the total renewable electricity in 2019. In the UK, hydroelectricity produces 1.65 GW of energy which accounts for approximately 2% of the national capacity. Most of the large hydropower sites have been already constructed in the UK so further development is unlikely due to financial and environmental concerns. However, run of river is a type of hydropower which could be further developed in the UK. The benefits of run of river hydropower include ease of smaller investments, shorter planning and construction times, use of a smaller area, and use of local labour and materials. There have been numerous worldwide studies and in the UK which claimed different ranges of available run of river hydropower potential for the remaining economically and technically feasible water resource. However, the latest UK-wide published study was done in 1989, which makes it outdated. The present study's aim is to create a robust, replicable methodology to assess the potential of run of river hydropower in the UK. Building upon earlier work, this study determined the hydrological, technical, financially viable and realisable potential for pico, micro, mini and small run of river hydropower plants in the UK. The results show that the total hydrological potential is 20 GW, technical potential is 11 GW, financially viable potential is between 320 MW to 420 MW, the realisable potential is between 290 MW to 320 MW and most of the realisable schemes are either mini or small (100 kW – 5 MW) and are situated in the west and north-west parts of the UK.

Presenter	**Emily Howes**, Research Assistant, School of Energy, Geoscience, Infrastructure and Society, Heriot-Watt University (e.howes@hw.ac.uk)
Co-author(s)	**Ian Pattison**, School of Energy, Geoscience, Infrastructure and Society, Heriot-Watt University; **Jonathan Leake**, Department of Plant and Animal Sciences, University of Sheffield; **Lydia Smith**, NIAB; Patrick McKenna, NIAB; **Sami Ullah**, School of Geography, Earth and Environmental Sciences, University of Birmingham; **David Jones**, School of Environment, Natural Resources and Geography, University of Bangor; **Adrian Collins**, Rothamsted Research; **Lisa Norton**, UK Centre for Ecology and Hydrology, Lancaster Environment Centre
Title	The Impact of Leys and Sheep Grazing on Soil Structure and Hydrological Functioning
Abstract	The intensification of agriculture in the latter half of the 20th Century has led to widespread decline in the physical quality of arable soils, including compaction, reduced hydrological functioning and increased runoff and erosion. If left untreated, this could threaten the sustainability of food production systems and ecosystem health. A variety of regenerative agricultural methods have been proposed to mitigate this, involving novel combinations of ley-arable rotations, integrated grazing and tillage management. Growing practitioner and policy interest has established a need for greater evidence of individual and combined effects of these practices on soil structure to establish clear guidance for the farming sector to facilitate more sustainable agricultural systems. We examine changes in soil structure, including bulk density, and functioning such as hydraulic conductivity and infiltration, following introduction of grass-clover and herbal leys and integration of sheep grazing and no-tillage cultivation across trial areas in eastern England. We aim to build a holistic understanding of how these approaches affect soil physical quality and hydrology, both at the field scale through a combination of field and laboratory methods and at the catchment scale via hydrological modelling. Preliminary findings from a site in Duxford, Cambridgeshire, indicate that soil pores were more homogeneously distributed in leys than conventional arable agriculture. Penetration resistance was significantly higher at 16-20cm under mowing than grazing in the herbal ley, whereas grazing and mowing showed any significant differences in penetration resistance in the grass-clover ley. Herbal leys had a significantly higher percentage soil moisture content than grass-clover leys.

Presenter	**Zuzanna Janas**, Student, University of Bristol (zuzaj@hotmail.co.uk)
Title	Identifying promising conjunctive use strategies in the UK
Abstract	Conjunctive use is the interchangeable use of groundwater and surface water depending on demand and resource availability. Flexibility in use of these resources allows for increased efficiency in using groundwater and surface water. Conjunctive use is important as it allows more resilient water supply, and it helps to protect groundwater and surface water levels. It is also advantageous in drought scenarios as there are multiple sources to supply a region and so deficits from one source can be managed more easily. The conjunctive use schemes employed by three UK drinking water companies (Thames Water, Affinity Water, Wessex Water) were analysed. The strengths and weaknesses of the conjunctive use systems of these companies were examined to see if there is an optimum approach that can be taken. The Water Resource Management Plans and Drought Plans of the companies were reviewed, and meetings were held with Thames Water and Affinity Water to discuss the schemes they have in place. The conjunctive use schemes were evaluated against criteria including their flexibility, the network connecting the sources to supply areas and water quality. It was determined that for a successful conjunctive use system, surface water and groundwater storage is necessary along with a well-connected network. These two components allow for flexible use of the water sources. To optimise a conjunctive use scheme, a modelling system can be introduced to model supply area demand and alternate water resources accordingly.

Presenter	**Claire Kennedy**, PhD Candidate, Department of Civil and Environmental Engineering, University of Strathclyde (claire.kennedy.100@strath.ac.uk)
Co-author(s)	**Douglas Bertram**, University of Strathclyde; **Christopher White**, University of Strathclyde
Title	The existing hydropower use of the United Kingdom
Abstract	In order to mitigate the effects of climate change there is an increased demand for energy produced from renewable sources. One such means of renewable energy production is utilising the energy from the hydro-environment. However, in order to accurately quantify the available resource and assess and site future facilities, it is necessary to know how much of the potential resource is still available in the United Kingdom. This requires knowing where existing schemes have been developed and the value of their installed capacity. This information is not comprehensively defined, but is rather haphazardly recorded over a number of government departments, environmental agencies, local authorities and developer records. The accuracy of such data is also not confirmed, with varying reports of installed capacities provided ranging from 1876-4712 MW. This research has undertaken a comprehensive review of available databases to develop an accurate picture of the existing hydro-energy environment across the UK, and to determine (1) accurate location of the developed schemes, (2) their means of energy generation (Run of River, Storage or Pumped Storage hydropower) and, (3) their installed capacity. The results of this study have quantified the existing installed capacity of the UK hydro-environment to be 4662.4 MW of hydropower generators, with geographic locations found for 82% of these schemes. Knowing the existing locations of such sites, allows for further, targeted research into the practical resource assessments for the hydro-environment to produce a realistic and site-specific resource potential as well as an analysis of optimisation of the hydro-resource use.

Presenter	**Alannah Killeen**, Hydrologist, UK Centre for Ecology & Hydrology (UKCEH) (alakil@ceh.ac.uk)
Title	ROBIN - A Reference Observatory of Basins for INternational hydrological climate change detection
Abstract	Climate models project that extreme hydrological events such as flood and droughts will likely become more frequent and severe, as a result of the warming world. To be able to adapt to the adverse impacts these events can cause, it is essential to understand the future changes in water availability. The studies of long-term changes in river flows globally such as the IPCC reports are relatively low in confidence, primarily due to the modification of river flows by human activities. The human influence on flow regimes can obscure climate change signals and distort trends, therefore to detect climate-driven trends we need to analyse river basins that are relatively undisturbed. Recognising this, many countries have created 'Reference Hydrometric Networks' (RHNs) collating river flow data where human impacts are absent or minimal. Globally, these RHNs are sparse and there is a need for an integrated approach to advance international assessments of hydrological change on a consistent basis, such that they can provide a robust foundation for regional and global assessments. The Reference Observatory of Basins for INternational hydrological climate change detection (ROBIN) initiative aims to advance a worldwide effort to bring together a global RHN. With a growing network of partners from around 27 countries spanning a broad range of climates and geographies, over the next two years ROBIN will develop a consistently defined network of near-natural catchments across the world. This network will be used to undertake the first, global scale analysis of trends in river flows using minimally disturbed catchments.

Presenter	**Ibrahim Lawal**, PhD Candidate, Department of Civil and Environmental Engineering, University of Strathclyde (ibrahim.lawal@strath.ac.uk)
Co-author(s)	**Douglas Bertram**, University of Strathclyde; **Christopher White**, University of Strathclyde
Title	A combined empirical and hydrologic model concept for blue/green water-based accounting framework for assessment of water security in data-sparse regions
Abstract	Several water-related concepts can be considered, while accounting for the green and blue water types specified in line with the hydrological processes, to provide a thorough assessment of the vulnerability and scarcity of water resources. However, accurate hydrologic model development is challenging in data-sparse regions where climate change impact on basin hydrology and water quality processes is necessary for a well-informed water policy decision on adaptation and hazard mitigation strategies due to climate change. Here, we demonstrate strategies for improved climate dataset evaluation that further reduce the transfer of uncertainty and improve hydrologic modelling output. Highlights from the proposed methodology indicate improved and consistent representation of basin climate with lower bias compared to previous approaches found in the literature. Assessment of the return period of drought and flood hazard using the methodology showed an improved statistical trend and magnitude of extreme events and enhanced model results of hydrologic variables for water resource assessment. Further work focuses on developing a new framework to conceptualize and redefined boundary conditions for green and blue water quantitative analysis to provide enhanced indicators of water scarcity and vulnerability at the basin scale in data-sparse regions. The proposed framework will be useful in the integration of empirical and hydrologic model concepts, ecosystem, and human needs information, thereby improving our understanding of how and where present and projected water-related threats to human and aquatic ecosystem security can arise due to climate change.

Presenter	**Ali Leonard**, WIRe PhD Candidate, Newcastle University (a.leonard4@newcastle.ac.uk)
Title	Multi-scale water resources planning in England and Wales
Abstract	Defining the bounds of water resources issues is difficult given complex physical and institutional arrangements. How should we be matching and aligning the scale of our institutions and governance to the scale of the problem for water resources management? This is the central question of this research project using England and Wales as a case study. Water resources planning in England and Wales has undergone several historic shifts in scale. These shifts have occurred in a non-linear fashion responding to a complex landscape of drivers and pathway dependencies, both physical and institutional. Recently, a more strategic approach involving regional and national scale planning has emerged in response to calls to increase resilience in the face of climate change, growth, and environmental pressures and the failure to gain consent for large new infrastructure assets. The change in approach creates new requirements for alignment, cooperation, and resourcing and represents a significant challenge for the privatised and regulated water industry that has evolved locally and heterogeneously within different physical and company contexts. To analyse whether the scale of governance and new institutional arrangements are suited to the problems they face we are interviewing some of the key actors and observing meetings between regional actors and regulators to identify key challenges and opportunities that have arisen. One area of focus is exploring if decision-making approaches and assessment criteria are appropriate for national planning. The research is ongoing alongside the current planning cycle and will hopefully lead to insights into how to design our water resources institutions to align with the scale of the problems they are designed to face.

Presenter	**Copper Lewis**, PhD Candidate, Heriot-Watt University (cmel2000@hw.ac.uk)
Title	Quantifying the effectiveness of Natural Flood Management interventions in a heavily modified lowland catchment
Abstract	Natural Flood Management (NFM) measures emulate natural functions of river systems to attenuate the flood hydrograph by storing water and slowing its movement through the catchment. These techniques are important tools in helping to build societal resilience to increasing flood risk, yet uncertainty remains regarding their effectiveness due to complexities and non-linearities of individual catchment characteristics and hydrological processes contributing to flood generation. Following repeated flooding events in the Swaton Eau catchment, Lincolnshire, a pilot NFM project has been developed to reduce flood risk to 63 properties in 3 villages. Five offline attenuation ponds have been installed to provide storage for excess water moving through the channel network and 29 field-edge swales intercept overland flow, providing a combined storage capacity of 46,000m3. This study aims to quantify the impact of the NFM features on the hydrological response of this lowland, agricultural catchment at varying scales. Water level sensors arranged in a nested array will record how the impacts of the attenuation ponds propagate through the catchment whilst a network of soil moisture sensors installed within the swales will monitor the local-scale impact on the movement of water into the channel network. Due to heavy clay soils, much of the catchment is underlain by artificial subsurface drainage in addition to the straightened surface drainage ditches prevalent across this landscape. Data will be gathered to investigate how the NFM measures interact with the heavily modified catchment. Empirical evidence gathered in the field will be used to develop and calibrate a hydrological model.

Presenter	**Yuexiao Liu**, PhD Candidate, Department of Civil Engineering, University of Bristol (mg18511@bristol.ac.uk)
Co-author(s)	**Lu Zhuo**, School of Geographical Sciences, University of Bristol; **Maria Pregnolato**, Department of Civil Engineering, University of Bristol; **Dawei Han**, Department of Civil Engineering, University of Bristol
Title	May a statistical interpolated method improve ERA5 rainfall accuracy? A case study in the region with distinct topographical features
Abstract	The global long-term reanalysis dataset is a promising alternative for understanding the Earth's water cycle thermodynamics. Derived by running a sophisticated land surface model with the coarse ERA5 near-surface fields, ERA5-Land is the latest reanalysis dataset. With the main merit of a higher resolution (~ 9 km), ERA5-Land could therefore be perceived to have a significant improvement over the ERA5's rainfall dataset (~ 31 km). However, would a simple spatial interpolation of the original ERA5 data improve its data quality is worth investigating. Moreover, currently there lacks a comprehensive evaluation between the ERA5-Land and interpolated ERA5 rainfall products over various topographical features, time scales and rainfall intensities. Emilia-Romagna (Italy), which has abundant precipitation records and heterogeneous topographical features, is selected as the study region. Results show that the simple interpolated ERA5 rainfall by the ordinary kriging method (ERA5-OK) can achieve nearly the same spatial-temporal performance as ERA5-Land's at all time scales, even better at the daily scale. In particular, it slightly outperforms over ERA5-Land in the high-altitude mountainous zone, which tends to suffer from frequent hydrological hazards. Moreover, in the coastal zone, the interpolated ERA5 is recommended to substitute the ERA5-Land because the latter contains null values. This work provides new insights for further interpolating ERA5 into finer resolutions and applying long-term ERA5 data in climate change and natural hazard research. Although the study area covers distinct topographical features, it is still important that similar studies should be encouraged over other regions to further validate the findings with this procedure.

Presenter	**Euan Macdonald**, PhD Candidate, Department of Civil and Environmental Engineering, University of Strathclyde (euan.macdonald@strath.ac.uk)
Co-author(s)	**Enrico Tubaldi**, University of Strathclyde; **Edoardo Patelli**, University of Strathclyde
Title	Probabilistic framework for robust predictions of extreme wave characteristics
Abstract	Alerting responsible authorities to the possibility of overtopping flood defences due to extreme water levels is integral to the safe operation of coastal transport infrastructures. As such, it is critical to design a system to identify these events to responsible authorities giving them enough time to take meaningful action to mitigate the potential impacts of these hazards. Wind driven surface waves are a component of this water level which are difficult to predict given the complex physics that govern their generation and transport. Machine learning algorithms such as artificial neural networks are powerful tools for analysing data and constructing predictive models. They are well suited to problems that consider a high number of nonlinear and complex variables making them an appropriate choice for this application. For some regions such as the Firth of Clyde in southwest Scotland, real data is not always available in the desired quantity or quality to train these tools to an operational standard and so reanalysis hindcast data is used in its place. An adaptive Bayesian model selection application is presented for the Firth of Clyde that quantifies the uncertainty in the characteristic predictions for extreme surface waves with a 95% confidence interval, including an investigation of the correlation structures between wind magnitude and surface wave, data preprocessing and dimensional reduction techniques and optimal network architecture selection.

Presenter	**Michael MacDonald**, Graduate Hydrologist / Environmental Scientist, Kaya Consulting Ltd (mgmacdonald@dundee.ac.uk)
Co-author(s)	**Andrew Black**, University of Dundee
Title	Baseflow and Hydrograph Comparisons in a Data-Sparse Rewilding Catchment
Abstract	Rewilding projects are the embodiment of a paradigm shift in land management practices across the UK, and in particular, the highlands of Scotland. Rewilding is viewed as a means of restoring ecological potential and is expected to have positive implications for natural flood management as managers seek to utilise nature-based and process-based approaches to mitigating increased flood risk in a time of changing climate. The 230km2 Feshie catchment forms part of the 200-year vision of the Cairngorms Connect project, an unusually large, landscape-scale rewilding mission taking place in the Scottish Highlands. Since becoming instrumented in ~2016. A more spatially intense monitoring network has facilitated new insights into the hydrological response of the data sparse upper Feshie catchment as previously, the entire catchment was monitored only at its outlet into the river Spey. The study presents comparisons of the 2 main neighbouring ~30km2 sub catchments of the upper Feshie catchment which have contrasting physical characteristics. The main findings include hydrological comparison through empirical median hydrographs and lag time analysis. The study was achieved through a multi-step process including the Vbar method for rating extension due to the extreme remoteness of these gauges. The findings are examined against existing literature and BFIHOST to help gain new insights into the catchment response of the Upper Feshie. These analyses may facilitate spatial and temporal comparisons once built upon as the catchment forest regenerates and peat recovers, assisting with resilience to high flows under climate change conditions.

Presenter	**Hazhan Majeed**, PhD Candidate, Heriot-Watt University (hsm1@hw.ac.uk)
Co-author(s)	**Ian Pattison**, Heriot-Watt University
Title	Quantifying the Effectiveness of Natural Flood Management Measures for Reducing Flood Risk: Optimizing for Scale and Location
Abstract	In the last decade, there has been an emphasises on using natural methods to reduce the risk of flooding which is set to increase due to climate change and land use intensification. As a result, natural flood management measures such as storage ponds, leaky barriers and flood plain restoration, etc., have been applied upstream in a number of catchments to investigate their effectiveness as flood mitigation methods. Evidence from current studies suggest that NFM can only be effective for reducing flood risk in small catchments and for small/moderate events. However, the NFM measures in these catchments have been applied at a small scale and their locations were chosen on an opportunistic basis. There is still uncertainty in whether NFM can be effective for large catchments large events. We argue that, for NFM to be effective it needs to be designed like any other flood mitigation measure. I.e., it needs to be placed strategically throughout the catchment so that it reduces runoff from the source areas before it reaches the water courses. Therefore, in our research we will be investigating the effectiveness of NFM for upper Soar catchment in Leicestershire (area > 205 km2) using field monitoring and a distributed hydrological model to route runoff to the catchment outlet while accounting for the dynamic of the catchment processes in space and time, then use optimisation techniques to investigate the locations and the number of different types of NFM interventions that will provide optimum flood reduction.

Presenter	**Eleyna McGrady**, WIRe PhD Candidate, Newcastle University (e.mcgrady@newcastle.ac.uk)
Title	Groundwater Resilience under Extreme Drought
Abstract	Government guidance suggests that, by 2050, water companies should be resilient to a 1-in-500-year drought, allowing them to maintain supply in all except the most extreme droughts. However, drought is poorly defined with no universally accepted definition. This is because drought is often the result of many complex processes, is not a distinct event, and is usually only recognisable after a period of time. This leads to problems when predicting, quantifying, and assessing the impact and magnitude of drought within the environment. Consequently, how do water companies prepare themselves for an extreme drought when such drought cannot be quantified? Particularly, how do they ensure that groundwater resources are resilient, given the dependence on these resources to provide public water supply? These questions are particularly prevalent due to the predicted changes in climate and the current lack of understanding of how and to what magnitude groundwater resources will be affected. The principle focus of climate change research with regards to groundwater has been on assessing the likely impacts of general changes in precipitation and temperature patterns. However, the impact of predicted changes in rainfall intensity and spatial and temporal rainfall patterns on recharge and groundwater levels has had little exploration. This research project aims to address gaps in knowledge and fully understand the response of groundwater resources to changing climate, the impact of pre-cursor conditions on drought magnitude and duration, and aims to improve the current issue that is the lack of an adequate model that can be used to investigate these issues. Shetran and AquiMOD models will be used, focussing within the Fell Sandstone and Chalk aquifer regions.

Presenter	**Kieran Murnane**, Graduate Environmental Hydrologist, Mott MacDonald (kieran.murnane@mottmac.com)
Co-author(s)	**Tom Beskeen**, Mott MacDonald; **Peter Ede**, Mott MacDonald
Title	The Black Drin basin: A panoply of hydrological modelling challenges in the Balkans
Abstract	The proposed development of the Skavica hydropower project (HPP) in Albania requires detailed rainfall-runoff modelling of the transboundary Black Drin basin to inform baseline and future climate change energy assessments. This proposed HPP would sit above the existing Drini cascade of hydropower schemes which has a total installed capacity of 1400MW. The project is being developed by KESH, a public entity and the largest electricity producer in Albania, on behalf of the Government of Albania. The project aims to provide additional power production, provide downstream flood prevention and optimize the cascade by being the controlling dam. The mountainous Black Drin catchment contains two significant lakes, Prespa and Ohrid, with the former being a topographically closed catchment, connected to the latter by karstic groundwater flow. There are several upstream controls on river flows in North Macedonia including a controlled outflow from Lake Ohrid and the two HPPs (Globocica and Spilje). This presentation considers the technical and practical solutions implemented to address the complex challenges of this basin including karstic flow contributions, upstream flow controls, mountainous terrain influencing meteorological patterns, snow accumulation/melting and hydrometric data uncertainties. It will also outline the hydrological modelling methodology used in this investigation which includes the combination of GR6J rainfall-runoff models with bespoke reservoir simulation models.

Presenter	**Chisha Mzyece**, Commonwealth PhD Scholar, Faculty of Natural Sciences, Biological and Environmental Sciences, University of Stirling (c.c.mzyece@stir.ac.uk)
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Title	Developing a Bayesian Network model to account for catchment-scale faecal indicator organism losses from septic tank systems
Abstract	Changing frequencies and magnitude of rainfall associated with climate change are predicted to impact faecal pollution of water, inferred by the presence of faecal indicator organisms (FIOs). Common sources of FIOs in catchments include wastewater discharge, sewage spills and agricultural diffuse water pollution. While these sources are well recognised, little is known about risk posed by septic tank systems (STS) often common in rural catchments. Modelling approaches can help identify potential sources of FIOs in catchments to inform spatial targeting of land management mitigation measures for protecting water resources. However, given that empirical investigations of STS are limited due to challenges in monitoring STS effluent and uncertainties surrounding STS condition and maintenance, many models fail to account for STS contributions in their predictions, resulting in large uncertainty regarding their environmental risk. Bayesian Network (BN) models are widely acknowledged for their ability to integrate expert knowledge into model structures, and therefore, advantageous when empirical evidence or large-scale datasets are scarce. Here, the aim was to develop a probability-based model to predict FIO losses from STS to receiving waters by modifying an existing BN model developed to account for phosphorus losses from STS. The concept and need for an FIO BN model to inform on STS risk is presented, including, identification and justification of model variables and BN structure, approaches to model parameterisation and a description of the spatial data to be used to test this model in NE Scotland. The study will enhance understanding of BN FIO modelling to inform on options for addressing STS pollution.

Presenter	**Alem Oyarmoi**, PhD Candidate, Newcastle University (a.oyarmoi2@ncl.ac.uk)
Title	Assessment of impacts of papyrus dominated wetlands on catchment hydrology: case of Mpologoma catchment in Uganda
Abstract	Wetland loss since 1900 has been estimated at between 64% and 71%. This is a major issue internationally as wetlands make an invaluable contribution to multiple ecosystem services, from sustaining the hydrological cycle and regulating climate to protecting biodiversity. Among the continents, Africa is notable for having the largest area of wetlands of international importance, covering an impressive 7% of the continent. The giant sedge papyrus Cyperus papyrus L. (cyperaceae), the largest of the 400 tropical sedge species within the genus, constitutes the most widespread dominant species for a large proportion of these wetlands. In Uganda, few studies have been carried out on their hydrological regulating services. However, none have attempted to quantify its catchment scale flow regulation. Models are key to developing insights on dynamics of wetland ecosystem services. However, data availability poses limitation to their applicability in wetland based studies due to unique wetland properties. SHETRAN, a physically-based spatially-distributed hydrological model, was applied in Mpologoma catchment, Uganda, with the objective of quantifying impacts of papyrus dominated wetlands on baseflow and quickflow, including future flood and low flows. Despite limited data, it can be shown that wetlands play major roles in attenuating quickflow and enhancing baseflow.

Presenter	**Fangjun Peng**, PhD Candidate, Imperial College London / State Key Laboratory of Hydraulics and Mountain River Engineering, China (f.peng21@imperial.ac.uk)
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Title	Evaluating the impact of urban wetlands as natural-based solutions at the catchment scale
Abstract	According to SDG Report 2021, natural wetlands shrank by 35% between 1970 and 2015. Wetlands as one of the natural-based solutions in an urban area could solve the environmental problem including the deterioration of water quality and urban floods. We aim to explore the impact of wetland changes on water quality and quantity at the watershed scale, and no model has the same goal as us. Therefore, we developed Water System Integration Model (WSIMOD), which is a versatile open-source software established on Python. Different modules in WSIMOD, such as groundwater and wastewater, are interconnected to form the different parts of WSIMOD. The developing wetland module will be embedded into WSIMOD as one of them. This study aims to integrate the wetland model into WSIMOD across the water cycle to study the interactions and impacts of urban wetlands at the catchment scale. Our case study focuses on the London Borough of Enfield, which is located in the north of London. What we did is insert this wetland module into the WSIMOD in different ways, such as in different quantities or sizes, to observe the hydrological impact of wetlands as a proof of concept. The results show that scattered small wetlands can more effectively reduce the impact of a flood under the same total wetland area. Urban wetlands play a role in flood detention and water quality purification of watershed water resources at the catchment scale. This study conceptually simulates wetland processes, which can reveal the overall wetland state with acceptable accuracy.

Presenter	**Eleonora Perugini**, Marie Sklodowska-Curie Fellow, Department of Civil and Environmental Engineering, University of Strathclyde (eleonora.perugini@strath.ac.uk)
Co-author(s)	**Enrico Tubaldi**, University of Strathclyde; **Euan MacDonald**, University of Strathclyde; **Douglas Bertram**, University of Strathclyde; **Christopher White**, University of Strathclyde,
Title	Evaluation of image velocimetry techniques to monitor river flow properties at flood-critical bridges
Abstract	Climate change is widely recognised to be leading to more frequent and intense flood events. The intensification of the river action has an important impact also on stability of bridges crossing waterways. Bridge scour, the removal of sediments around bridge foundations due to the erosive action of flowing water, is currently one of the main causes of bridge failure in the UK and worldwide. The risk of bridge failure due to scour is expected to be exacerbated by the projected increase in winter precipitation and river flows as well as by the reduction of resources available for scour risk mitigation. Thus, it is expected that more bridges will be exposed to the scour risk in the coming years. Among the many approaches and techniques proposed over the years for scour monitoring, those relying on low-cost and non-invasive remote sensors are the most promising. This work illustrates the development of a novel approach for monitoring bridge scour hazard based on data on the river flow properties gathered from low-cost sensors. In particular, the proposed approach relies on image velocimetry algorithms for processing video recordings from a variety of fixed and mobile cameras. The information on the surface velocity can be related to mean depth velocity and is used together with hydraulic and scour models to obtain estimates of the temporal evolution of scour. The proposed monitoring approach is currently being deployed at a bridge in Scotland, which is already equipped with scour probes providing data useful for validation.

Presenter	**Marta Ponti**, PhD Candidate, Department of Civil and Environmental Engineering, University of Strathclyde (marta.ponti@strath.ac.uk)
Co-author(s)	**Deonie Allen**, University of Strathclyde
Title	A framework to assess the impact of flooding on the release of microplastics from waste management facilities style
Abstract	The impact of flood on waste management facilities can induce the release of micro pollutants to freshwater systems with concerning impacts on the marine environment, agricultural ecosystems, and human health. Almost 30% of the total waste managed in the UK in 2019 was characterised by Microplastic Releasers (MPRs): plastic waste, synthetic textile, rubber waste, and mix/undifferentiated materials that are able to or contain items that can deteriorate and fragment into micro components. In recent years, the management of solid waste and its contribution to flood-driven microplastic pollution has been limited with a focus on plastic waste mismanagement specifically, and the assessment of the risk is long overdue. We present a new methodology combining publicly available data on waste with pluvial and fluvial flood extent maps. The methodology was applied to the UK where the impact of pluvial flood on waste management facilities shows a 3-fold increment between 20 and 50-year return period in waste at risk of releasing microplastics during inundation resulting in almost 5 million tonnes per day. The methodology was applied to the UK where the impact of pluvial flood on waste management facilities shows a 3-fold increment between 20 and 50-year return period resulting in almost 5 million tonnes of waste per day at risk of releasing microplastics during inundation. We conclude that further studies at the local scale are necessary to establish site-specific mitigation measures and containment systems able to decrease the flood-induced microplastic mobilisation from waste management facilities.

Presenter	**Anna-Louise Prince**, Stantec (annalouise.prince@stantec.com)
Title	Quantifying abstraction impacts in the Water Resources West region
Abstract	Water Resources West (WRW) is one of the strategic groups seeking to deliver the Environment Agency's National Water Resources Framework. WRW consists of abstractors including five Water Company (WC) core members across the western region that are working together with the EA to ensure sustainability of water resources. One of the aims of this project was to source and quantify the main abstractions, see how abstractions compared against environmental flow indicators (EFI) and identify opportunities to collaborate across stakeholders to address EFI non-compliance. I undertook this process by collating Public Water Supply (PWS) and Non-PWS abstraction data from the EA, Natural Resources Wales, and the Canals and Rivers Trust covering the period 2010-2015. These abstractions were grouped into WFD Operational Catchments (OCs) and consumptive use factors applied. I also forecast future demand for each sector using published growth estimates or WC supply demand balance tables. I then screened the abstractions within each OC against EFI values from the Water Availability Assessment undertaken as part of the latest national Climate Change Risk Assessment (CCRA3) for three scenarios; current, Mid-Century and End of Century. The key results of the analysis were; •the power sector was the Non-PWS sector with significant water usage across WRW, but in terms of consumptive use, this was reduced in comparison with other Non-PWS sectors. •OCs within the centre of WRW had the greatest EFI non-compliance. These results were used to assist identifying pilot catchments for further analysis to support cross sectoral collaboration on water resources management.

Presenter	**Donald Robertson**, PhD Candidate / HydroNation Scholar, Department of Civil and Environmental Engineering, University of Strathclyde (donald.j.robertson@strath.ac.uk)
Title	Citizen-derived data as an important tool in tackling the climate emergency. Case Study: water management in Malawi
Abstract	The climate crisis is a water crisis. Driven by a changing global climate, water-related challenges are becoming more common and impactful. With water sitting at a dynamic interface between the environmental, social, economic, and political pillars of sustainability, tackling these challenges requires scientists and wider society to think beyond traditional, discipline specific approaches to management. Popularised by initiatives like Integrated Water Resources Management, the demand for 'data' in water management has steadily increased, supporting the planning, modelling, and forecasting of current and future water related challenges. However, reliance on data-driven processes, particularly in resource poor settings, presents challenges of its own. Enter: citizen science. Citizen science, a rapidly growing field which facilitates public participation in science, presents opportunities for data hungry scientists, practitioners, and policy makers. Yet, citizen science, and the data derived from citizens, presents opportunity far beyond data generation including the incorporation of community voices, increasing the accessibility of data, creating inclusive and transparent decision making processes, and improved social learning. These opportunities match well against calls for improving water, and wider environmental, management practices in the face of a climate emergency. However, there remains a number of unknowns as to how citizen-derived data is effectively integrated into institutional practice and how best the potential benefits are harnessed beyond single project initiatives. Using Malawi as a case study, this presentation will discuss the key water challenges, the transformative role that citizen-derived data can have in them, and what questions still exist for water professionals to resolve.

Presenter	**Saskia Salwey**, PhD Candidate, School of Geographical Sciences, University of Bristol (ss16144@bristol.ac.uk)
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Title	Large-scale detection of reservoir impacts through hydrological signatures
Abstract	Reservoirs play a vital role in the supply and management of water resources and their operation can significantly alter downstream flow. Despite this, reservoirs are frequently excluded or poorly represented in large-scale hydrological models. This is partially due to a lack of open-access data describing reservoir operations, particularly operating rules, inflow and storage data. To help inform the development of reservoir functions, we collate a suite of hydrological signatures designed to detect the impacts of reservoirs on the flow regime at large-scales from downstream flow records. To demonstrate their application, we calculate the signatures across Great Britain in 111 benchmark (i.e. near-natural) catchments and 186 reservoir catchments (where at least one upstream reservoir is present). We find that abstractions from water resource reservoirs induce deficits in the water balance, and that pre-defined flow releases (e.g. the compensation flow) reduce variability in the downstream flow duration curve and in intra-annual low flows. By comparing signatures in benchmark and reservoir catchments, we define thresholds above which the influence of reservoirs can be distinguished from natural variability and identify 40 catchments significantly impacted by the presence of reservoirs. The signatures also provide insights into local reservoir operations, which can inform the development of tailored reservoir functions, and identify locations where current modelling practices (which lack reservoir representation) will be insufficient.

Presenter	**Rozy Shepherd**, Analyst, JBA Consulting (rozy.shepherd@jbaconsulting.com)
Title	Small catchment flows – Investigating the FEH equation for adjusting drainage path length (DPLBAR)
Abstract	The FEH catchment descriptor DPLBAR (that generally represents drainage area in a catchment) is a variable in the equations used in ReFH2/FEH rainfall runoff modelling, and therefore, peak flows output from this modelling software are directly influenced by the DPLBAR value used. My presentation will consider the uncertainty of using the FEH equation DPLBAR = Area0.548 compared to using the default DPLBAR from catchment descriptors, on design peak flow outputs for small catchments (using ReFH2). This FEH equation is suggested for use, in volume 5 of the FEH, if a catchment area is adjusted manually following download of catchment descriptors from the FEH webservice and background mapping checks. I analysed trends in uncertainty from a sample of 40 catchments from around the UK, ranging from 1km² to 30 km², for both 'long and narrow' and 'round' catchments. The 'long and narrow' catchments had one long watercourse running through the catchment, whereas the 'round' catchments had many smaller watercourses. The default catchment descriptors (including DPLBAR) were input to ReFH2 and resulting peak flow outputs were used as the control variable against peak flow outputs that had been calculated from using DPLBAR value as derived from the FEH equation. Percentage difference between peak flows was calculated for all 40 catchments and trends showed that using the recalculated DPLBAR value for 'long and narrow' catchments resulted in higher peak flows, whereas for round catchments, it resulted in lower. This research showed that DPLBAR and the resulting peak flows are sensitive to catchment shape.

Presenter	**Keith Shotton**, PhD Candidate, Newcastle University (k.shotton1@newcastle.ac.uk)
Co-author(s)	**Elizabeth Lewis**, Newcastle University; **David Pritchard**, Newcastle University; **Nick Rutter**, Northumbria University
Title	Developing precipitation datasets for mountain regions in a changing climate
Abstract	Although it is vitally important for future water resources, we have a relatively poor understanding of spatio-temporal precipitation patterns in mountain regions. Gauge networks are sparse and traditional methods of interpolating between point measurements yield inadequate precipitation fields for ungauged and poorly gauged catchments. This project involves stochastic reconstruction, using an inverse hydrological modelling approach, combined with a random mixing method in a Monte Carlo framework, to generate multiple realisations of precipitation fields, conditioned on precipitation gauge and streamflow observations. The initial test catchment is in the front ranges of the Canadian Rockies. Ensemble simulations will be run, using hydrological model (both conceptual and physically-based) outputs to optimise precipitation inputs. Sensitivity of generated fields to seasonality, elevation and precipitation phase will be tested. Ensemble simulation outputs will be analysed for spatial precipitation patterns, characteristics of flows and spatial distribution of snow. The project aims to identify global-scale ingredients for random spatial fields in mountain regions that can be applied in other parts of the world and to explore how climate change impacts these elements. Spatial fields will be generated using other stochastic methods to evaluate advantages and disadvantages of each. Long time-period flood frequency curves (i.e., 100 or 200 years) produced using each approach will be compared, as well as evaluation of different methods of phase partitioning to identify impacts on extreme flooding which is often controlled by snowpack melt. Climate change perturbations will be applied to generate potential future flood estimates.

Presenter	**Ilona Szabo**, Hydrologist, Mott MacDonald (ilona.szabo@mottmac.com)
Title	Development of a rainfall-runoff model based drought forecasting tool applied in the Anglian region
Abstract	Water companies are required to take timely actions with regards to droughts as per the Water Company Drought Plan Guidance. Currently, the UK Hydrological Outlook provides country-wide outlooks based on historical climate patterns and 1- and 3-month Met Office rainfall forecasts which helps with these assessments. However, an improved linkage between the current water company hydrological situation with the hydrological outlook for the months ahead would provide significant benefits for drought planning and provide additional lead time for decision makers. This is particularly relevant given the projected impacts of climate change and links with increased demand during heatwaves. GR6J models have been calibrated on a large scale across the UK aided by new, enhanced meteorological datasets. This presentation outlines recent work to implement a drought forecasting tool and dashboard that links GR6J rainfall-runoff models with near real-time HadUK observational data, 3- month ECMWF meteorological forecasts and probabilistic scenarios. In collaboration with Anglian Water these datasets have been combined allowing them to be applied directly to calibrated models and provide a forecast of flows over a set number of months. An interactive dashboard, updated with recent meteorological on a weekly basis, has been developed to visualise, and extract, these model results to provide a range of flow projections (or reservoir storage) supporting drought monitoring and forecasting for key water resources, thus improving lead time for decision makers.

Presenter	**Chenyuan Wang**, Undergraduate Student, University College London (chenyuan.wang.19@alumni.ucl.ac.uk)
Title	Assessing the Impacts of Climate Change Using Hydrological Modelling for the River Dee Catchment, Northeast Scotland
Abstract	A hydrological model of River Dee, NE Scotland, is developed, calibrated, and validated against observed discharges at nine gauging stations. Model performance is better in lowland areas than in upland areas. Implications of the Representative Concentration Pathway 8.5 scenario for the river flow are assessed using the perturbed precipitation and potential evapotranspiration generated from 12 UKCP18 regional projections for the period 2045 – 2080. Scenario results are compared to a 1982 – 2017 baseline period. Declines in annual mean precipitation predominate (- 6.2% to -12%), mostly between May and October, while most climate models suggest increases in winter precipitation (+3% to +53%). Potential evapotranspiration (PET) increases for all scenarios. Catchment-wide increases in temperature range from +1.9℃ to 3.6℃. Annual mean discharge over the catchment declines by 7.7%. Low flows (Q95) decline substantially for all scenarios while there is greater uncertainty in the magnitude and direction of changes in high flows (-14.4% to +16.6%). Potential impacts include enhanced winter flooding and summer thermal stress under low flow conditions for protected species such as the Atlantic salmon.

Presenter	**Xilin Xia**, Assistant Professor in Resilience Engineering, School of Engineering, University of Birmingham (x.xia.1@bham.ac.uk)
Title	An integrated hydrodynamic model for flash flood and debris flow simulations
Abstract	Because of climate change, there are more frequent and intensive storms in the UK and other parts of the world, which may consequently cause more hazardous flash floods in steep catchments. These flash floods are commonly characterized by rapid-varying overland flow because of complex and rapid catchment response to intense rainfall. In catchments where loose deposited debris exists, the flood water may mobilise the debris and turn into deadly debris flows, which hold enormous damaging power and pose significant threats to people, property, and infrastructure. Hydrodynamic models based on solving the full shallow water equations (SWEs) have shown great potential to reliably simulate the dynamics of overland flows and flash floods at catchment scales. However, simulating the transition from flash flood into debris flow is extremely challenging because of the difficulty of representing erosion and deposition processes within numerical models. In this work, we have developed a novel integrated hydrodynamic model for simulating flash floods and debris flows. The overland flow processes are simulated by solving the full SWEs using a Godunov-type finite volume method. A novel method for calculating erosion and deposition rates is incorporated into the SWEs-based model to simulate the change of debris concentration. Therefore, the new model can simulation the full process of rainfall turning into debris flows. Satisfactory simulation results have been obtained for both laboratory-scale and real-world test cases. The new model has the potential to be applied for flash flood/debris flow risk assessment and early warning.