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The Ganges,
(from Pixabay – see back cover)

THE NEWSLETTER OF THE BRITISH HYDROLOGICAL SOCIETY

Brexit and the UK Water Sector

This was the theme of a major session at this year's meeting of the UK-Water Economics Forum (19th September 2016) since following the perhaps surprising result of the recent referendum on EU membership, Brexit has been the subject of much debate and speculation. The EU has had a large role in driving environmental legislative change and standard setting in the UK and it is estimated that as much as 80 to 90 per cent of the UK's environmental legislation is derived from the EU (DWF Law ref). The UK-WEF meeting was, therefore, rather timely.

The session opened with a talk given by Nick Haigh (Head of Analysis and Evidence Team, Defra) titled "A current perspective on Defra water economics (and post-Brexit challenges"). Following a brief overview of water economics in Defra, the speaker highlighted a selection of recent success stories and summarised some of the new challenges facing Defra which included natural capital and extracting the value of natural assets, for example river flows. The talk concluded with a very brief review of some of the post-Brexit challenges and opportunities, for example the opportunity to replace some of the existing rather arbitrary elements of the Water Framework Directive (WFD) with more meaningful goals that would potentially give better outcomes.

The focus of the meeting then turned to a debate which left the audience with much to think about. Stephen Topping (Managing Consultant, Europe Economics) opened with "Brexit – the opportunities for the water sector" – this assumed a 'Brexit Max' scenario and the flexibility to move away from EU legislation. The speaker viewed Brexit as an opportunity for the water sector to advise Government and to lobby for what it wants. There will be nothing to be gained by sitting back and doing nothing! The speaker also identified the flexibility of moving away from the arbitrary timeline of the WFD as representing a potentially hugely beneficial post-Brexit opportunity. Dr Bruce Horton (Director, Environmental Policy Consultancy/Principal Consultant, MWH Global) provided a brief overview of "The potential negative impacts of Brexit for water in the UK". Although the speaker emphasised that much is dependent on how Brexit evolves, impacts will include (1) increased uncertainty, (2) increased costs, (3) undermined environmental improvements, (4) loss of research funding/ opportunities and (5) impacts on the skilled workforce. The speaker concluded that the impact of Brexit will be felt in a range of areas and that many impacts will be both negative and significant.

The final speaker Dr Jonathan Fisher (Jonathan Fisher Environmental Economics) gave a quick-fire talk on "Brexit and the WFD" which considered some of the potential implications of Brexit, provided a brief overview of the history of European water policies and the WFD, and compared the WFD and best practice principles. Dr Fisher concluded by recommending that post-Brexit the WFD is retained with its essentially rational 'English' processes but with the GES 2027 target converted to more flexible 'aim to achieve' targets in subsequent

"....Brexit –an opportunity for the water sector to advise Government and to lobby for what it wants."

RBMPs. The EU WFD would essentially become the UK WFD (or EW WFD).

Following the Q&A panel session Dr Claire Johnstone (Economics Manager, Environment Agency) identified the main themes of the entire meeting as (1) valuation of natural assets etc, and (2) integrated approaches, for example natural flood management. Claire suggested that they (economists) take more risks and are more open to working with different groups. They could also make better use of technology and data and communicate in more visual ways.

My take-home message is that as hydrologists we are used to dealing with uncertainty and we should therefore view the uncertainty of Brexit as an opportunity to advise Government and to lobby for what the Society (and our rivers) wants.

The key question is whether the WFD should be retained in its current form or be replaced. Brexit is an opportunity to make legislative improvements, to put the water environment first and to cut red tape!

Emma Neachell

Selected online sources

British Water - Q&A Brexit http://www.britishwater.co.uk/article/qandabrexit-185.aspx "It is likely that the UK will continue to follow the best of the EU directives and extract itself from some of the more inefficient guidance for securing quality improvements. This will take time."

Country Land and Business Association Ltd (CLA) - Audit of EU Regulations (useful summary table) https://www.cla.org.uk/sites/default/files/Audit%20of%20EU%20Regulations.pdf

Country Land and Business Association Ltd (CLA) - New Opportunities: The case for a world leading food, farming and environmental policy https://www.cla.org.uk/sites/default/files/NEW%20OPPORTUNITIES.pdf

DWF LLP - The implications for UK environmental legislation following Brexit https://www.dwf.law/news-events/legal-updates/2016/07/the-implications-for-uk-environmental-legislation-following-brexit/ "It is possible that in the face of frequent criticism for non-compliance with EU environmental standards and legal challenges concerning the failure to achieve water quality standards, the UK might decide to relax standards and reduce controls."

Shepherd and Wedderburn - Brexit Analysis Bulletin: Water and Waste Water (summary PDF file) https://www.shepwedd.co.uk/sites/default/files/Brexit%20Analysis%20Bulletin%20Water%20and%20Waste%20Water.pdf

Water Briefing - Brexit and the water sector – an opportunity for Natural Infrastructure? http://www.waterbriefing.org/home/water-issues/item/12834-brexit-and-the-water-sector%E2%80%93-an-opportunity-for-natural-infrastructure

Water and Wastewater International - The Water Framework Directive: Where Next for Europe? http://www.waterworld.com/articles/wwi/print/volume-28/issue-2/regional-spotlight-europe/the-water-framework-directive-where.html

Water and Wastewater International - Brexit: UK water sector reaction http://www.waterworld.com/articles/wwi/2016/06/brexit-uk-water-sector-reaction.html

First-ever UNESCO Chair in Water Science

David Hannah, Professor of Hydrology at Birmingham University, will coordinate the activities as the UNESCO Chairholder. The aims are to facilitate inter-disciplinary research, education and awareness-raising to tackle water scarcity around the world.

Water scarcity has long been a source of conflict and sustainable approaches to reduce this risk furthers UNESCO's global mandate for peace.

HAIL

—David Archer discusses the historical evidence for its influence on flooding

Hail is a problematic aspect of the hydrological cycle that has received little attention. Its importance is recognised for the damage that it can cause to crops and especially fruit. Large hail can also kill flying and roosting birds, break slate roofs, cause damage to vehicles and be a hazard for aircraft (Webb *et al.,* 2009). However with respect to flooding hail has been given little consideration. Furthermore, it is difficult to measure in amount and almost impossible in intensity; weighing gauges offer some hope but even these are thwarted by wind effects.

Hail could be perceived to have a positive benefit in that it introduces a delay between precipitation and runoff; it is a comparatively rare occurrence and only rarely accumulates to significant depth. However, a survey of historical flash floods as part of the SINATRA project (Archer and Fowler, 2015) has identified a number of occasions and means by which hail can have a very significant detrimental effect on flood risk and damage. Since hail occurs in convective events, the effect is mainly with respect to flash floods caused by surface runoff rather than from the overflow of rivers.

Coagulated hailstones and associated flooding in Gateshead (Photo: 'The Journal, Newcastle', 7 August 2012)

There are three principal effects by which hail can enhance the impact of flooding:

1. Blocking of roof gutters.
A sufficiently heavy fall of hail especially when mixed with rain can accumulate in roof gutters causing water to overflow. Manchester Courier 8 June 1889 provides a historical example 'Hail and ice accompanied rain and broke many skylights. It was noted that at the Peel Park Museum on the parapets facing south the broad gutters had an agglomeration of drifted hailstones closely packed about 6 inches thick'. Blockage of gutters can cause the rain to run directly down the front of the buildings, gain access to interiors and add to surface water rather than being evacuated by the drains.

2. Coalescing and blocking of drains.
South Shields Gazette 9 June 1883 gives a historical example. Hail fell with rain especially at Stanhope (Upper Weardale) with some roads being flooded to a depth of two feet. The hailstones which were like large peas completely covered the ground and choked the sewer grates and the floods found their way into houses including Stanhope Castle and the curacy which was flooded to 18 inches, the worst flooding since 1852. A more recent example is provided by '*The Journal, Newcastle'*, for 7 August 2012 which has a photo

of a large block of coagulated hailstones.

3. Breaking of windows and skylights and allowing access of hail and rain into buildings. The principal hydrological effects are from the occurrence of very large hail or ragged pieces of clear ice to which there are numerous references in historical accounts. Observers give accounts of measurements by weight (100 g or more) or by dimensions (by diameter where spherical or by length and width where irregular) or simply by comparison with walnuts, pigeon's or bantam's eggs (e.g. Torro Size scale, Webb *et al.,* 2001). The impact of large hail especially associated with storm winds on windows has caused significant direct damage and also provided access through broken windows into room interiors for hail and associated storm rain.

In August 1846 such a hailstorm affected London and devastated major buildings (*The Standard,* 3 August 1846). The Houses of Parliament suffered breakage of more than 7000 panes and proceedings were interrupted. Buckingham Palace had all the skylights and many thousands of panes of glass broken; the rainfall poured down stairways in waterfalls and flooded the Picture Gallery to a depth of several inches. Houses in London were flooded up to 7 feet deep.

A storm in Richmond, North Yorkshire, in July 1893 broke 200,000 panes of glass and caused damage to interiors both from flooding and from shards of glass. The hail also killed chickens and caused head injuries and torn hats. Many severe hailstorms are very localised but the 'Richmond' storm also extended south to Harrogate where a similar number of glass panes were broken and hailstones as large as hen's eggs were reported, and to Goole where the stones were as large as pigeon's eggs and 'the streets were completely flooded'. The storm also occurred over the Pennines to Kirkby Stephen and Shap with broken windows and flooded houses.

Hail historical time series

A time series of hail associated with flash floods over the last two centuries, based on a chronology derived from historical sources, shows the decadal variability of large hail occurrence in Southwest England and Northeast England (Fig. 2). It is probable that the less frequent reporting in recent decades of hail causing serious breakage of glass is due to the increased glass strength but the decline in other reports of large hail must reflect a real decline in occurrence.

Southwest and Northeast England are some of the least favoured regions for large hail in England and Wales but a similar pattern is reported for the whole of England with decadal decline from a maximum around the turn of the 19th/20th century and a minimum occurrence in the 1970s (Webb *et al.,* 2009). In addition, Archer *et al* (2016) show a corresponding sharp decline in the decadal frequency of occurrence of flash floods from the first to the second half of the twentieth century in Northwest and Southwest England. .

These observations do not appear to accord with climate model projections which indicate an intensification of precipitation with increase with temperature according to the thermodynamic Clausius–Clapyeron (CC) relation (a rate of~6–7%°C^{-1}) – a warmer atmosphere being capable of holding more moisture (Chan *et al.*, 2016). Such intensification has been demonstrated for rainfall in numerous studies and in different locations, with locally higher than CC scaling (so-called

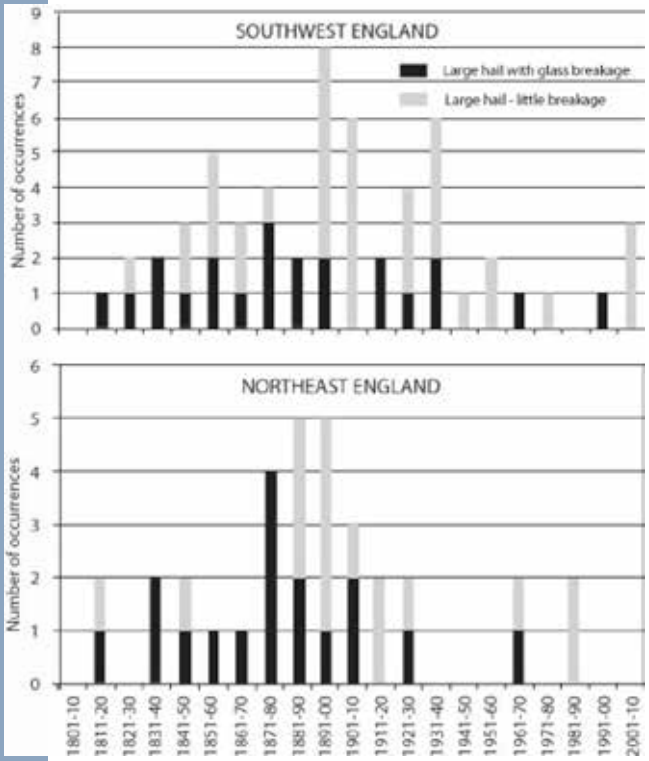

Figure 2 Number of occurrences of large hail with and without reported extensive glass breakage for Southwest and Northeast England.

super CC scaling) observed for sub-daily extremes (Blenkinsop et al 2015). Webb *et al*. (2009) have identified synoptic conditions and associations of large hail occurrence and Lamb Weather types but these hardly explain the time distribution of occurrences.

Sanderson *et al.* (2014) use a regional climate model to project hailstorm frequency and intensity during the 21st century in the UK. Their analysis suggests a downward trend in numbers but they acknowledge that the results are subject to large uncertainties partly originating with the convective parameterization scheme. Projections of future climate need to incorporate historical natural variability as demonstrated for hail and flash floods. This will require a more determined effort to account for the time distribution and assess causes and correlation with other climatic phenomena.

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History of Hydrology Wiki

A recent update has meant that there are now over 100 biographies of hydrologists on the History of Hydrology wiki site (history-of-hydrology.net) ranging from Ackermann to Yevjevich (I have not yet found out enough about Zoch or others beginning with Z to warrant an entry).

A new section has also been added on the Histories of Experimental Catchments. This is intended to be complementary to the Experimental Hydrology wiki (experimental-hydrology.net – do take a look if you do not know it already) in recording more about the histories of both past and present experimental sites. There are not many entries yet – if you are involved in running an experimental catchment (or were in the past) then you might want to consider adding an entry so that the history is recorded for posterity. This can by all means include personal anecdotes. I would like to see many more stories about the interactions between different hydrologists and their catchments.

The site is completed by sections on Hydrology Texts and the histories of Hydrological Institutions.

Suggestions for new entries in any of the sections are always welcome, but since this is a wiki site you can very easily register with the site to add material to the existing entries or add new entries yourself (templates are provided for the different sections). If you do see any errors in the information on the site then please either register to make a correction or let me know by email.

I would like the site to be as international as possible, so there is no reason why your entries should not be in languages other than English (though a summary in English would always be helpful, please!). I very much hope that many hydrologists might take the opportunity to participate in building up this store of information about the history of hydrology in as many countries as possible.

Hyrological Consultants

BHS is a repository of a range of skills and expertise and our membership includes many professionals engaged with national and international consultancy firms as well as those who operate in an individual capacity.

We therefore maintain a '***Register of Consultants in Hydrology***' on our web site as a service both to members and to others looking for hydrological advice and assistance.

Our listings do not carry official endorsement and are intended purely to facilitate contact, but this is a facility much appreciated by many enqurirers. We should like to ensure that it is as up to date as possible. Details of how to join the Register are given at www.hydrolgy.org.uk/consultants.php

Hydrologists make the water go round

4th BHS International Conference and AGM

Cranfield University, 30 Aug – 1 Sept 2016

Our 4th International Conference was a stimulating event with many examples of the centrality of hydrology to many societal challenges. These challenges were the focus of our invited plenary speakers. Professor Charles Vorosmarty (City University New York, USA) elaborated and illustrated the threats to the global water system and the role of intact environmental services. In the Cranfield University's Lorch Lecture Professor Ximing Cai (University of Illinois, Urbana-Champaign, USA) called for a paradigm shift to deal with the challenges of sustainable water resources management. In the Penman Lecture Professor Elias Fereres (University of Cordoba, Spain) explored the management of water limitation in agriculture under future food demand scenarios. Presenting a UK perspective on the 2015-16 floods and on responses to floods at a time of uncertain climate futures, our two key speakers called for a return to basics in using data and applying physically-based models to understand extreme events. Our Past President, Nigel Goody (SEPA) summarized experiences of recent floods in Scotland especially with regard to the challenges of stream gauging during extreme events to obtain accurate flood data. Professor Roger Falconer (Cardiff University) illustrated the dangers of rapid assessment methods and the necessity for physically-true models in understanding flood wave development in catchments of contrasting morphometry.

These contributions were complemented by a wealth of papers on a suite of important contemporary themes: managing flood risks; water resources management for growing populations; soil hydrology, agricultural sustainability and food security; hydrology in cities; and river restoration including a workshop on sediments in rivers and opportunities to improve understanding.

The proposed public debate on Brexit following the excellent Gala Dinner didn't happen but I introduced the issues. In summary: since the 1970s the EU agreed over 200 bits of legislation to protect the environment. EU procedures were intended to improve the quality of decision-making, increased participation in decision-making, and build capacity across member states. The Water Framework Directive (23/10/2000) was to introduce an innovative approach focusing on river basins and aquatic ecosystem protection with 'good status' being achieved by 2015 (but 47% of water bodies failed). Perhaps most influential has been the Conservation of Habitats and Species Regulation (2010). From

a legal perspective, simple confirmatory legislation is likely to ensure statutory provision for the EU Directives but Brexit offers a chance to develop our own distinctive policies and standards that are effective, alongside the international frameworks of which we are part. The loss of EU grant aid to support environmental initiatives (e.g. the recently announced EU supported - in addition to Heritage Lottery Funding and other Government support - project to protect and grow the Twaite Shad population in the River Severn) would need to be replaced by new Government funding.

The BHS is not a lobby group and some would argue that Government is about politics not evidence, but given the diversity of our membership should the Society provide a one-stop-shop for unbiased, factual and practical information upon which decision-makers can make informed judgements? Are we prepared to leave such functions to other bodies? Passionate discussions continued until the bar closed – and resumed the following morning!

Finally, our sincere thanks go to Dr Tim Hess and his colleagues at Cranfield University for a well organized and much enjoyed event.

Geoff Petts

The AGM on 1st September

provided an opportunity to thank Nigel Goody who had come to the end of his term as Past President and many years active involvement with the Committee, and to welcome back **Peter Ede** (past Treasurer 2005–9) as President Elect. We also welcomed to the Committee **Scott McGrane** (University of Glasgow).

The society's activites of 2015–16 were formally presented by Ian Pattinson describing an active and successful year In addition to 4 National meetings, there were 8 regional meetings organised by the Society's six current Sections covering a wide variety of topics ranging from flood alleviation schemes and drought risks to ecohydraulic modelling and ecosystem services.

The Peter Wolf Symposium was held on the 26–27th May at Bristol University. Thanks to Fanny Sarrazin, Joost Iwema, and Susana Almeida for organising. More than 40 young hydrologists attended showing that the future of our discipline is bright. **Ludovica Beltrame** (University of Bristol) was awarded first prize for her presentation, "Simulating the risk of Liver Fluke infection using a mechanistic hydrological epidemiological model", while **Wouter Knoben** (University of Bristol) was awarded first prize for his poster, "Towards methodological modelling: Differences between the structure and output dynamics of multiple conceptual models".

The President referred to continuing activites of the Main Committee including: review the statutes, strengthen the planning of our meetings schedule, return to a balanced budget following a few years of planned budget deficits to reduce our reserves in line with Charity Commission advice, and develop our role as a Specialist Knowledge Society of the ICE, perhaps through stronger partnerships with the British Dam Society and Irrigation and Water Forum.

The Society continues to seek ways to improve the ways it keeps in touch with Members. We have plans to improve the quality of our website and we welcome any suggestions on its usefulness and appeal. Furthermore, we

have developed our presence on social media, with 1549 members on LinkedIn (up 118 on last year) and 813 Followers on Twitter (up 385 on last year).

The Treasurer reported an operating loss on the year, but we are looking towards operating on a break-even basis in the years to come.

Income:
There has been small reduction in subscriptions while levels from website advertising has been maintained and has been very active over the last couple of months. We hope these levels of income will be maintained, despie volatility over recent years.

Studentship scheme: There was in increase in income in that the BHS committee agreed to award 8 studentships, part funded by the JBA Trust. Additionally we received the generous donation of the royalties from the publication of "*Progress in Modern Hydrology – Past, Present and Future*", by John C. Rodda and Mark Robinson. The authors requested the funds be allocated to the benefit of young hydrologists, and the monies will be used to continue the studentship scheme.

Register of consultants: This has been well supported by independent hydrologists but income from companies has dropped recently. There are opportunities for the BHS to increase income from this source over the next 12 months.

Expenditure:
Travel Awards: There was an increase in demand for BHS Travel Awards in 2015/16. We are looking to update the way applications are assessed to ensure awards are fair and transparent.

Newsletter: The newsletter remains one of the largest annual committed outgoings.

Changes to the Main Committee

Our new President-elect is **Peter Ede**, Technical Director for Hydrology at Mott MacDonald where he has worked for over 30 years, and in close to 30 countries. However, not so much travelling recently, and he is currently busy with UK work, primarily water resources assessments for water companies at this busy stage of the AMP cycle. Peter was previously on the BHS Main Committee from 2003 to 2009, and was the Hon Treasurer from 2005 to 2009.

Scott J. McGrane is a research fellow in the School of Mathematics & Statistics at the University of Glasgow.

I am currently involved in an EPSRC funded project that seeks to assess the interlinkages and feedbacks across the water, energy and food sectors in the UK at contrasting spatial scales.

I completed my PhD in Catchment Hydrology at the University of Aberdeen in 2009 and I am particularlyinterested in the impacts of environ-mental change on catchment systems. In my spare time I am a keen golfer and I am also an avid fan of both the NFL and MLB, having spent a lot of time in the USA throughout my life.

You can find out what I'm up to via my Twitter account @DrScottJMcGrane

Aquator® User Group Autumn Meeting
11–12 October 2016

The tenth Aquator®User Group Meeting was held at the Worcester College, University of Oxford. Jointly promoted by Oxford Scientific Software (OSS) and Hydro-Logic Services (HLS), this two-day event was attended by 40 delegates drawn from the UK water industry regulators, the Canal & Rivers Trust, water companies and consultancies.

The Day 1 training programme started with morning break-out parallel sessions covering three topics: Aquator for new users, Advanced features of Aquator and Using VBA with Aquator. The following afternoon plenary and sequential sessions covered two topics: AquatorXV including porting existing models and AquatorXM.

The Day 2 user group meeting commenced with Colin Fenn of HLS and Will Clark of OSS introducing an overview of the programme for the day with a special welcome to Anglian Water and Dwr Cymru Welsh Water who are now joining the users group. This was followed by presentations of a range of Aquator related case studies, including:

- Peter Edgley of OSS on AquatorXV Update – The Future of Aquator
- Chris Green of OSS on Aquator XM Update – Execution Manager for Fast Processing on Stand-Alone and/or Cloud computers
- Kevin Mountain and Mark Morley on the Lower Thames Control Diagram Optimisation using Aquator Genetic Algorithms
- Tiffany Lau and Stephen McGuire on a Scottish Environmental Protection Agency's Hydropower Study
- Richard Gosling and Ellie Willmott on the Application of the WFD's Building Block Methodology using AquatorXM

The keynote address was delivered by Jamie Hannaford of the Centre for Ecology and Hydrology entitled "Improving Information for Drought Planning and Decision Making" and included a personal family history of links with the UK historic droughts of 1933-34, 1976 and 2010-12. Jamie advised on the wealth of information available via the UK Drought Portal at https://eip.ceh.ac.uk/droughts

David Mould from the Canal & Rivers Trust (CRT) introduced the informal technical meeting group as a complementary association to the Aquator users group. It is a self-help alliance currently involving the CRT, United Utilities, Severn Trent Water and Anglian Water.

A discussion followed the presentations with suggestions on potential needs of current and prospective users captured to inform future development of the Aquator software package.

Aquator User Group meetings are held annually, with a bi-annual combined Training Day and User Group meeting. It provides ample opportunities for users to meet and discuss their experiences of working with Aquator.

For further information on the User Group, and Aquator in general, contact Dr Kunle Akande at kakande@hydro-int.com (01189 331325) or visit http://www.oxscisoft.com/.

Obituary

It was sad to learn of the untimely death of **David Collins**, a key member of the hydrological fraternity. He will be much missed.

Hydroecology and the fine sediment conundrum: quantifying, mitigating and managing the issues

The erosion, transport and deposition of fine sediment is widely recognised to be a major cause of habitat and ecological degradation and the BHS meeting, held in the Department of Geography, Loughborough University on 6th July 2016 provided a great opportunity for those with an interest in the most prevalent ecological fine sediment problems to get together under one roof. The meeting attracted 73 delegates from across the UK and Europe and included a broad range of consultants, river and water managers, policy-makers, stakeholders and researchers working at the sediment-ecology-flow interface. A wide range of talks and posters were on offer from large-scale river restoration projects and application of macroinvertebrate biological traits in the assessment of fine sediment pressures through to the novel utilization of remote sensing for applied catchment management strategies.

As postgraduate students at Loughborough University, organising, attending and helping out with the hosting of the event was a great opportunity for us. The first session began with a keynote talk from Richard Chadd and Chris Extence (Environment Agency) who discussed the practical applications of a sediment specific biomonitoring tool, the Proportion of Sediment sensitive Invertebrates (PSI) Index. David Bradley (APEM) followed by discussing the broad application of a weight of evidence approach through application of a range of mitigation measures and sediment monitoring tools. John Murphy (Queen Mary University of London) presented findings on the use of biological traits as an alternative biomonitoring tool to assess stresses caused by fine sediment impacts.

The second keynote of the day was by Adrian Collins (Rothamsted Research) on mitigating fine sediment losses to rivers from agriculture. Multi-scale perspectives were put forward that referred to new targets which aimed to characterise ecological impacts and further the monitoring of the efficacy of on-farm interventions. Chris Stoate (Game and Wildlife Trust) presented results from a landscape scale BACI on two tributaries of the River Welland and the challenges associated with reducing sediment inputs from surrounding arable land.

Strong links were shown to exist between the amount of sediment lost into rivers and the type of buffering strips and afforestation techniques used. Rosalinde Nicholls (University of Leicester) discussed the quantification of fine-grained sediment storage within areas of the East Midlands. This was followed by an insightful account into the application of remote sensing in catchment sediment management processes from Peter Stone (APEM). Pilot investigations successfully identified, at a field scale, the areas that were most highly at risk of diffuse sediment pollution incidents, thus providing a visual and interactive tool for engaging with stakeholders and landowners.

After a fantastic lunch and a re-dose of caffeine, the afternoon

session was kick-started by Gary Bilotta (University of Brighton) who gave a keynote presentation on the establishment of 'natural' and 'reference' sediment dynamics. Using reference condition data he highlighted the variable range of natural background concentrations present in temperate UK rivers and discussed how water guidelines need to recognise these variations in order to protect the waterbodies.

Philip Greenwood (University of Basel) discussed the interactions that plants (and animals) can have with the environment in the newly emerging field of biogeomorphology. He focused on the relationship between the invasive Himalayan Balsam and soil erosion levels within temperate river systems with occurrences of very high magnitude soil erosion events often being initiated by the presence of Himalayan Balsam.

Martin Wilkes (University of Coventry) provided a different perspective on biomonitoring tools suggesting the need for more mechanistic foundations on which to base many of the commonly employed bio-monitoring tools. A number of talks during the afternoon session considered the ecological implications of fine sediment dynamics at varying trophic scales.

David Milan (University of Hull) spoke about the findings of a yearlong study into the grain size variations and spatial patterns of fine sediment in areas of spawning gravel for salmonid embryos. His study specified the need for incubation-to-emergence models to aid in the in the prediction of fine sediment dynamics at a pool-riffle scale. George Bunting (University of Worcester) discussed on-going research through experimental channels investigating fine sediment pulses and interstitial habitat availability on benthic invertebrates. Melanie Fletcher (Freshwater Biological Association) concluded the days meeting with practical insights from a river restoration project on the River Gowan, with the conservation objectives of the project strongly aligned towards mitigating the implications of enhanced fine sediment loads during the work.

A number of posters were also on display during the day. These reflected the wide range of researchers present at the meeting ranging from the relationship between fine sediment and geomorphology, specifically concerning sediment transport and management solutions, to those that identified the implications of fine sediment and ecology. The variety of academic and applied research projects on show led to some interesting discussions over the course of the day during coffee breaks.

This meeting was an immensely enjoyable one, full of interesting talks describing cutting-edge research and succeeded in bringing together an international collection of people all concerned with similar issues. The organising committee at Loughborough University (Kate Mathers, Prof. Paul Wood and Prof. Stephen Rice) would like to thank the British Hydrological Society for facilitating the meeting in addition to the support of the Freshwater Biological Association and the Environment Agency for making it such a successful event. We hope that all attendees found it as useful and insightful as we did.

Kelly Clinton and Kate Mathers
Loughborough University

Is national flood AAD really only £93m-to-£116m, rather than £1.3bn?

asks Edmund Penning-Rowsell

The average level of flood risk in this country (the annual average damage, or AAD) is an important metric, providing a context to both effort and investment to reduce it. But the official AAD for England and Wales at c. £1bn - £1.3bn has been disputed (Penning-Rowsell, 2013; 2014a&b). This has probably helped spur a complete revision of the underlying NAFRA model by the Environment Agency (hereinafter "EA").

My Circulation paper (Penning-Rowsell, 2014b) had a 2013/14 limit on the data analysed, but there has been further flooding since, including following storm 'Desmond' in 2015/16. Serious damage occurred, with 17,000 properties flooded (David Rooke at Floodrisk16). However, even the substantial damages suffered are unlikely to shift far the previous average of claims-based losses discussed in these papers.

My results in Penning-Rowsell (2013), hereinafter referred to as "EP-R", were the subject of a thorough EA-funded critique by Matt Horritt (2014). This was described by Horritt as a "constructive process of identifying where the NaFRA and EP-R numbers were not directly comparable, and then trying to correct for these". His report looks at length of record issues, coastal flood damages, surface water flooding, the 2007 event, and some issues from previous studies. His suggested corrections to the EP-R AAD are summarised in Table 1. In reply this paper discusses each of Horritt's key issues in turn, aimed ultimately at identifying deficiencies in NAFRA1 by which to suggest improvements via NAFRA2.

In terms of record length Horritt indicates that "EP-R's analysis is based on 13 years of record, from 1998 to 2010, and so a fundamental question is how representative is the average which is estimated from this data. Two methods have been used to answer this question: an analysis of annual maximum flow data from HiFlows UK, and evidence from the R&D project SC060088 (Keef et al., 2011) on spatial coherence in flood risk" (Horritt, 2014,3).

He concludes from the former that "The 12 year average looks fairly stable, implying we should be able to extract a useful average from 12 or 13 years of data" (Horritt, 2014, 4) and from the latter that: "Spatial coherence in flooding means that it is possible to make a meaningful estimate of annual damages from a 12 year record, provided an adjustment is made to better represent the long term average. The EP-R 1998-2010 average should be reduced by 40% to allow for this being a significantly wetter than average period" (Horritt, 2014, 8). [Hydrologists might like to explore the magnitude of this "wetter than average" phenomenon in future issues of Circulation.]

Regarding coastal flooding Horritt (2014) suggests that total flood risk is equal to fluvial risk plus 70%. He indicates that the data used by EP-R for 1998-2010 includes only a very small coastal component because of high standard of coastal protection. This is corroborated for him by the absence of reported coastal flooding; total flood risk should therefore be the 1998-2010

average plus ~70%.

But if this multiple of 0.70 were correct, then 41.2% of the NAFRA AAD total of c. £1bn would be from coastal flooding or a coastal AAD of £412,000,000 [i.e. 0.7/(1.00 + 0.7) = 0.412]. This is implausible, when the record of UK coastal flooding over the last 100 years is quite sparse, with only one really major event (1953: £5bn losses at 2010 prices). Indeed, after 1953 there was major flood defence expenditure to prevent any repeat. Horritt has since written (Sept. 2016): "I concur with this way of looking at things – it does look like the coastal element is overestimated when you look at the record of damages. I suspect it's the pessimistic fragility curves that contribute a lot of this risk".

Moreover Horritt's coastal analysis assumes NAFRA is correct in counting property numbers within its probability bands at the coast. But one of my contentions is that the NAFRA counts are wrong. For example, NaFRA suggests that there are 141,000 coastal properties at risk of flooding with a return period of less than 1: 75 years (Horritt, 2014,Table 2.6). We would surely have expected at least one flood of this scale since 1953 if these property numbers are anywhere near accurate. But only Towyn and Boston have seen significant numbers of coastal properties flooded, and nowhere near 141,000. The actual average damages from coastal locations must be quite low: Horritt's 0.7 multiplier looks far too high.

With surface water flooding, EP-R recognized that the claims data used included areas other than the fluvial and coastal floodplain: areas NaFRA does not count (Penning-Rowsell, 2013, 2014a). Horritt concludes in this respect that "Claims data are likely to include significant contributions from sources other than rivers and the sea. For direct comparison with NaFRA outputs, (his) claims figures should be reduced by 30-50% to allow for surface water (flooding)".

The 2007 flood event was the largest since 1947 or 1953 and thus important in calculating an AAD from past losses. Horritt (2014) reveals a discrepancy here, starting with Chatterton's assessment of the numbers of properties flooded based on 132,000 insurance claims, totaling £1.72bn (the source is "The most recent correspondence with the ABI (May 2009)" (Chatterton et al, 2010b,11)). Chatterton's best estimate of total economic losses is £0.91bn, which is then up-rated to £1.3bn on the basis of only 75% "covered by insurance" (a % that is almost certainly too low). Horritt then converts this to £2.1bn (financial) using the EP-R 62.5% 'economic-to-financial' uprating factor. He compares his £2.1bn (financial) with the £1.051bn (financial) in EP-R, and concludes "The £2.1bn residential financial losses figure is twice that quoted in EP-R's review …. If this discrepancy is consistent for all years, then the claims should be adjusted by +90%." (Horritt, 2014,11).

But later ABI data from their official Domestic claims record (ABI, 2012) gives the total flood claims (residential only) for 2007 as £0.973bn, which when up-rated for 2007-2010 inflation gives the figure of £1.051bn used by EP-R and which contributes to an average over the 13-year record period of £0.226bn (designated incorrectly as "economic" in Penning-Rowsell, 2014a). The 'discrepancy' that Horritt identifies is a function of a change in data from the ABI. The early data, in May 2009, gives the figure of £1.7 billion for domestic claims (a source we cannot verify, because it was based on correspondence) but this was (presumably) superseded by the data presented later in the official ABI

dataset and used by EP-R to give a much lower average.

Finally, in examining other issues, Horritt's report seeks to explain why the NAFRA £1 billion figure is so large, identifying possible errors in the NAFRA process. Two areas are relevant here:

1. Standard of protection and risk profile issues;
2. Errors in WAAD (The "Weighted Annual Average Damages" summary statistic used in NAFRA (Penning-Rowsell, 2013)).

In the first, Horritt (2014,17) gives two examples. In the North-East region half of the total EAD comes from events below the 10 year return period; much of the floodplain in Carlisle has NAFRA flood likelihoods of 4% or greater. Both seem hardly credible and are perhaps the surest indication of serious problems with NAFRA's results.

In the second, he suggests that the event damage from a 100 year event implied by the WAAD value of £79, at £7,900, is "very significantly lower than the damage per property seen from insurance claims (£30k according to the ABI)" (Horritt, 2014,18).

But the £30k figure is a financial figure, needing its VAT deducted (= £25,532) and deflated to economic values (= £15,957). Moreover the ABI suggest that domestic flood damage claims are in the range £20,000-£40,000 and Weathernet's average was £24,303 (Chatterton et al, 2010). Deflating these lower values still gives a value greater than £7,900 (i.e. £12,927 from the Weathernet average), but not inordinately so, and perhaps therefore shows there is no major problem with the WAAD dataset.

Horritt reported on "Uncertainty analysis" and suggests that "it should therefore be no surprise that EP-R's figure of £300-350 million differs by a factor of 3 from the £1bn NAFRA figure, as the uncertainty in the £1bn is so large". But his 'correction' of EP-R's range to £0.23-£0.50bn (Table 1) is only obtained as a result of adjusting the EP-R figures for coastal losses (+70%), uninsured losses (10%), and the 'discrepancy' in the 2007 flood damage data between EP-R and Chatterton (+30 to 90%). However all three are now disputed, above, leaving the total AAD (i.e. not just residential but all NAFRA sectors) in a range of £0.093 bn to £0.116 bn (Table 2). This range is now surely outside the range suggested by Horritt's "Uncertainty analysis".

The conclusion here is that whilst I suggested in Circulation an exaggeration factor for NAFRA over assessed flood damages of 3 to 4 times (Penning-Rowsell, 2014b), this now looks like an exaggeration factor of more like 10 to 12 times. Paul Bates of Bristol University reviewed a longer version of this paper in draft [see the Annex in Penning-Rowsell (2016]) and concluded that "….it seems to heading to there being a real discrepancy between observed losses and NaFRA WAAD that is

Table 1. Horritt's (2014) summary table

	Factor/adjustment	*£bn*
EP-R's annual average residential financial claim		0.23
Convert to economic losses	x0.625	0.14
Adjust for non-residential	x2.63	0.37
Wetter than average period	-40%	0.22
Include coastal losses	+70%	0.37
Uninsured losses	+10%	0.4
England and Wales only	-10%	0.37
Allowance for surface water	-[30-50]%	0.18-0.26
Discrepancy for 2007 between EP-R and Chatterton's analysis	+[30-90]%	0.23-0.50

Table 2. Summary table from the changes listed in this paper

Item	*Factor/ adjustment*	*£bn*
A. AAD in *Transactions* paper (all sectors, not just residential, from an average of all data)		0.25
B. AAD in *Transactions* paper (all sectors, not just residential, from the residential data, as done by Horritt above but corrected as per Penning-Rowsell (2014b) footnote)		0.322
Wetter than average period (1)	Horritt's -40%	0.193
Include coastal losses (2)	0%	0.193
Uninsured losses (3)	0%	0.193
England & Wales only (4)	0%	0.193
Allowance for surface water (5)	Horritt's -40%	0.116
Discrepancy beween EPR and Chatterton data (6)	0%	0.116
Final adjusted AAD (from residential dataset ONLY with its value of 0.322 (B above), reduced twice by 40%		0.116
Final adjusted AAD (from all four datasets with its value of 0.25 (A above) (actually 0.2595 to 4 sig. figures) reduced twice by 40%)		0.093
NAFRA estimate		1.0 – 1.3

Note 1: Horritt's analysis of a wetter than normal period for 1998-2010, not included by EP-R.
Note 2: There seems no good reason to adjust for what is not happening very much: coastal flooding and hence coastal AAD.
Note 3: These (and under insurance) are allowed for in the EP-R analysis @ 20%.
Note 4: The all-UK data is adjusted by EP-R for Scotland, by multiplying by 84.5%.
Note 5: Horritt's 40% reduction seems very large in relation to actual SWF but is used here nonetheless.
Note 6: EP-R used the most up to date ABI data (after 2010) rather than Chatterton's (higher) 2009 data.

greater than uncertainty….. Whether the discrepancy factor is 3x, 12x or in between is somewhat secondary: suffice at this stage to conclude that it's there and can't be explained by uncertainty".

Edmund Penning-Rowsell
Middlesex & Oxford Universities

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Last winter's floods reviewed

This new publication is to be released shortly — estimated launch date 5/6th December, the anniversary of storm Desmond which resulted in the largest recorded daily outflow from Great Britain.

'The winter 2015/2016 floods in the UK – a review'* documents the hydrometeoroloigcal aspects of the disasterous flooding episodes within the context of lengthy rainfall and river flow time series. The magnitude of the flooding relative to other historic floods is considered and the hydrological trends emerging over recent decades. Many detailed papers on specific aspects of these floods are now coming through the refereed literature but the authors' aim is to bring together all relevant data across the whole spectrum of hydrological interests as an invaluable reference work for the future.

New members

Farhan Aziz .....Mouchel Consulting Saudi Arabia
Charlotte Beattie .....J B A Consulting, Warrington
Ludovica Beltrame .....Bristol University
Douglas Bertram .....Strathclyde University, Spain
Nicholas Drewett .....Katherine Colby Consultant, Stroud
Sarah Edwards .....Canal & River Trust, Hatton
Rachel Kewley .....Environment Agency, Warrington
Sylvain Kuppel .....Aberdeen University
Morwenna McKenzie.....Coventry University
Alex Minett .....JBA Consulting, Harrogate
David Ocio Moreno .....Mott MacDonald, Cambridge
Matthew Perks .....Newcastle University
Nathan Rickards .....CEH Wallingford
Ruth Robinson .....Leeds University
Alan Roscoe .....Writtle College, Chelmsford
Adam Searle .....Sale
Christopher Smith .....Ricardo Energy & Environment, Manchester
Daniel Walker .....Hydro-Logic Ltd, Birmingham

Evapotranspiration – a career-long view

David Evans' short piece in Circulation No. 130 "Evapotranspiration – the invisible thief" is thought-provoking, if somewhat emotively stated. As stomata are involved in the process of photosynthesis, the use of water as a conveyor is an essential part of transpiration. As photosynthesis uses carbon dioxide, which we are repeatedly told we have too much of, any user of CO_2 should perhaps be encouraged. I sense an implication in David's note that as a 'thief', something should be done to control these evil stomata! I'm sure defoliation and mass removal of vegetation would not be welcome, or hopefully thought feasible (although covering productive fields in solar panels seems to have been taken up).

Jim Dent has some pertinent comments

I would however like to record a few personal thoughts with the hope of providing a perspective of the role of evapotranspiration, which sometimes seems to be the neglected component of the hydrological cycle. We all know it is there, and every diagram of the atmospheric and hydrological cycle includes it, but when it comes to observation, measurement and modelling, evapotranspiration often falls into the "too-hard" category.

When starting my hydrological career as a Field Assistant at Queen's University, Belfast (in autumn 1968!) I was involved in instrumentation and monitoring of some small upland catchments. Establishment of losses through evaporation and soil moisture fluctuations were involved. After some rather 'Heath-Robinson' attempts at constructing a lysimeter with a plastic dustbin balanced on a water-filled inner-tube in a pit, we stuck to piezometer measurements and estimates of PET from meteorological data. Other attempts at using lysimeters during work with Sussex River Authority (1972–74), again met with little real success, so reliance was placed on Penman estimates from a network of climate stations. Whether or not this really helped to fine-tune the water balance of the South Downs and Greensand aquifers, I don't know. Some water companies (Brighton and Cambridge) operated lysimeters for some time from the 1970s, but I am not sure if they still exist.

Judging by the descriptions in The WMO Guide to Hydrological Practices, the most widespread use of lysimeters has been in Russia. The only private long-running lysimeter record that I am aware of in England is that maintained by Dr Colin Clark at his observatory in Bruton, Dorset. Perhaps Colin could provide some comments?

During my period of working abroad on irrigation and water balance studies in Indonesia, Malaysia and the Indian sub-continent, estimation of evaporative losses depended on measurements from the Class A evaporation pan. This deceptively simple piece of equipment was fraught with difficulties. It needed to be kept clean and properly maintained, with the water level kept within a certain range in relation to the rim. Obviously any rainfall needed to be taken into account, and if there was heavy rainfall, say 10 mm or more in a day, the balancing calculations could go severely haywire. Then there was the selection of appropriate pan co-efficients to apply to different crop and soil types. All too easy just to apply a blanket multiplier, used widely over the sub-Continent, the reference for which I found was

a report on work on the Lower Indus project in Pakistan in the 1960s! The condition of most evaporation pans, inspected on a Wallingford Water project in Rajasthan in 1995 by my colleague Dr Ian Strangeways, left much to be desired.

Following my return to England in the 1990s, I became involved in abstraction licence determination in west Suffolk and Norfolk, and was amazed to find that very little direct science was applied to industrial scale agricultural irrigation in one of the driest parts of England. Apart from a few prominent research organisations, the best information to hand for water balance studies was the weekly crop reference EVT and soil moisture deficit (SMD) issued by the Met Office on a 30 km grid – MORECS.

During the period of frequent serious wide-spread flooding between 2000 and 2002, the Met Office and Environment Agency flood forecasting and warning endeavours tried to develop a more definitive set of EVT/SMD data under the MOSES system, which was supposed to see the phasing out of MORECS. The MORECS data was supposed to provide a better representation of catchment wetness, both as an antecedent value and also to define change of moisture conditions during the storm duration.

Whether or not better EVT/SMD information improved flood forecasting and warning, I don't know – forecast performance evaluation studies in the mid 2000s did not provide encouraging results. But to this day, the small national map of SMD included in the Monthly Hydrological Summary uses MORECS grid-square data! The publication of MOSES data by the Met Office in the mid 2000s was very restricted and costly to external users, and no doubt discouraged external research and consultancy users – I don't know if this situation still pertains.

The short-term time-frame and local area definition provided by MOSES would seem ideally suited to catchment scale modelling. However, as EVT, at least potentially, is not a highly variable component of any water balance or rainfall-runoff model, it has tended to be used as a generalised figure, e.g. the monthly average. This somewhat crude approximation is probably subsumed within other approximations in data and model structure, and does not, seemingly, cause concern that the approximation affects the sensitivity of the results.

With the current advanced sensors, computation facilities, remote sensing and data transmission, it should in theory be possible to produce near real-time EVT data, and make it part of the routine, rather than the "nice to have" item of my earlier career. I would point out that Met Eireann does provide daily readings of EVT and SMD as part of their agricultural section of their website. Could EA and the Met Office provide something similar?

James Dent

Seen at Cranfield.....

A posse of Presidents (or should that be a 'pride' of'?) pretending to be three wise monkeys.....

Hydro-Informatics 2016
Song-do, Incheon, South Korea
21—26 August 2016

The 12th HIC was held at the Song-do Convensia, Incheon, South Korea, on 21-26th August 2016. I was attracted to this conference by the Special Session on Inverse Problems as my PhD project is involved with developing and testing a novel method for inverting a continuous-time transfer function model that can be used to infer catchment rainfall from runoff [1,2] then used to identify and attempt to quantify uncertainty in catchment rainfall estimates.

My conference presentation showed some early results from using reverse hydrology to assess the information content of individual rain-gauges used to calculate catchment average rainfall – the best estimate of the 'true' rainfall over a catchment. These early results indicate that, in general, using inferred rainfall to simulate catchment out flow gives a better match to the observed outflow than using the rainfall from an individual gauge. Traditional modelling uses the information from rainfall only whereas reverse hydrology is able to utilise the information on both rainfall and catchment dynamics contained in the outflow. Results so far indicate that inversion is able to extract the flow generating rainfall from the noisy rainfall input signal.

The procedure was tested using the intensively instrumented Brue catchment in Somerset. From the 49 rain-gauges available, a subset of 23 was chosen for analysis and their locations are shown in Figure 1. An example plot for one single rain-gauge for a single autumn event is shown in Figure 2 illustrating the improvement in the fit of the simulated catchment outflow using inferred rainfall over observed rainfall from a single gauge.

Further work will look at a wider range of events and using this method to identify disinformative gauges which may then be removed from the calculation of catchment average rainfall to give a better estimate of catchment rainfall that can be used as input to other types of model and the effect of gauge network density. This work will form a chapter of my thesis and I plan to write it up formally as a paper.

The first four days of the conference

Fig. 1 - The Brue catchment showing the position of the 23 gauges used in the analysis.

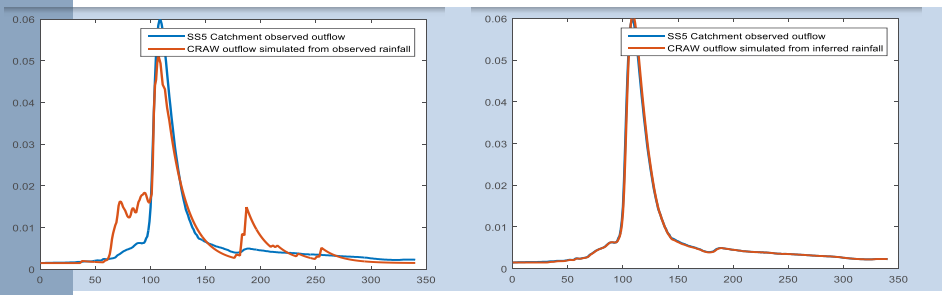

Fig. 2 Example plots of simulated outflow from a single gauge (CRAW). Left-hand plot shows catchment outflow simulated using observed rainfall at the gauge (R_t^2 = 0.881) and the right-hand flow simulated using inferred rainfall. (R_t^2 = 0.998).

were taken up with talks on a wide range of subjects by delegates from all over the world: however the theme that ran through almost all of them was the need to estimate, quantify and COMMUNICATE uncertainty in a way that can be understood by non-specialists. The Introductory and Plenary sessions gave some interesting insights into the context of Hydroinformatics (defined as connecting water, information and mathematics) highlighting that the issues of flooding and droughts are global and may lead to water becoming an economic driver in the future, bringing challenges that require interdisciplinary understanding with Hydroinformatics as the bridge between deep science and sustainable solutions.

All earth systems (including anthropogenic) are interlinked and their functions need to be understood as a whole rather than as separate disciplines. Dragan Savic (Exeter) talked about Smart Cities (of which Songdo is an example) and emphasized that water is a long way down the priority list despite examples, such as London, where demand for water is projected to outstrip supply in the not too distant future. He stated that it is vital to engage citizens since currently they are only interested in water if they are personally affected by too much or too little!

The conference proceedings have been published in a special edition of *Procedia Engineering* (**154**, 1-1448 (2016) 12th International Conference on Hydroinformatics (HIC 2016) - *Smart Water for the Future*. Eds: Joong Hoon Kim, Hung Soo Kim, Do Guen Yoo, Donghwi Jung and Chang Geun Song http://www.sciencedirect.com/science/journal/18777058/154).

The final day of the conference included a Technical Tour including a visit to the Sihwa Lake Tidal Power Plant, the largest in the world, with a total output capacity of 254Mw, and a cruise on the Gyeongin Ara Waterway with a traditional Korean barbecue lunch as a bonus. The waterway is 18 km long and links the Han River with the Yellow Sea. It was originally built for flood control but is now used widely for leisure purposes. At both the Tidal plant and the Waterway, we were given introductions by K-Water and taken up their impressive viewing towers. These seem to be a feature of Korea and included not just displays and coffee shops but places to sit and relax – and they are free.

At Sihwa there was even a range of books available to encourage children to read (they may have been for adults too but of course being in Korean I couldn't tell!).

It was with great trepidation that I approached both the conference and the trip to South Korea as it

was my first international conference and my first visit to Asia. I need not have worried however as everyone I met both at the conference and around Songdo was friendly and helpful. Koreans are obviously very proud of their country and want people to like it and to visit. Songdo itself did not exist until recently. It has been built, just outside Seoul, from scratch on land reclaimed from the Yellow Sea and is described as "The City of the Future" or "The World's Smartest City". It is a sea of skyscrapers but when viewed from the G-Tower (G stands for Green, Growth and Global) viewing gallery you can see how much greenery has been incorporated (see photos). The city is eco-friendly and extensive use is made of solar and geothermal energy – even the shaded seating areas are roofed with solar panels. I walked through Central Park and it was obvious that, although planned and reminiscent of its American namesake, it has been designed to be used with a boating lake, fitness trails, walks and shaded seating areas. A Korean I met on the plane, told me that Songdo is the place everyone aspires to live and bring-up their families and he was obviously very proud of the fact that it was where his family lived.

I met many people from all around the world and had the opportunity to talk to them about their work but almost more importantly to talk to them as people. It was obvious that wherever in the world they came from, their concerns are the similar both professionally and personally. Would I do it again? Most definitely and I would spend a little extra time to see the country I was visiting.

A big thank you goes to those who supported me to attend this conference. I received funding from the NERC Credible project, BHS and the Faculty of Science and Technology and Graduate College at Lancaster University. The patience of my supervisors, Wlodek Tych, Nick Chappell and Keith Beven at Lancaster Environment Centre, is greatly appreciated: without their support I would never have made it.

Ann Kretzschmar

The G-tower from Central Park and solar panel roof over a seating area at Sihwa

The Hydrogeomorphology of Flood Risk

The 2016 British Society for Geomorphology annual conference was hosted by Plymouth University in September. This year, an extra session extended the BSG annual meeting into late Wednesday afternoon and thus allowed a joint meeting of the BSG/BHS* to discuss hydrogeomorphological aspects of the recent 'exceptional' flooding in the UK. The event was very well attended by academics, environmental consultants, individuals form River Trusts and an entourage from the Environment Agency.

Geoff Petts (University of Westminster) and Dave Gilvear (University of Plymouth) introduced the meeting, noting its topicality given the flooding in Northern England in December 2015 and January of 2016. They also reminded the audience that the South West of England has had its own issues over the years with the Somerset Levels flooding in the winter of 2013/2014 and flood events such as Lynton and Lynmouth on the 15th August 1952 and Boscastle on the 16th August 2004.

Andy Large (Newcastle University) presented the first paper, describing the NERC SINATRA programme involving a dedicated Flood Action Team set up to gather high calibre data following flash flooding. Andy stressed the importance of understanding the concept of shifting baselines in managing floods. This was followed by a presentation by PhD student Fiona Clubb (University of Edinburgh) introducing a new automated approach (FIRTH), first-order approximation, to mapping floodplains from digital elevation models. The technique was tested using observed floods in the USA and UK and from predictions based on CAESAR-Lisflood hydrological modelling.

Richard Chiverrell (University of Liverpool) and colleagues described the reconstruction of a flood record from lake sediment sequences in Bassenthwaite, including the floods of December 2015 (Storm Desmond). They are still working on the Storm Desmond data but other work has shown that the devastating 2009 flooding in the Derwent catchment was the largest event in 425 years and may have a recurrence interval far larger (1:9000 year) than conventional analysis based on short-term records (1:700 year).

Andrew Brookes (Jacobs Engineering and United Utilities) highlighted how the recent 'extreme' floods in Northern Britain and Scotland have caused significant channel change and threatened important assets. Emergency responses have been needed and in some cases legal action. To identify assets threatened by future flooding an 'erosion risk prioritisation tool' has been developed and Andrew showed how geomorphology now has a formal place at the 'design table'.

The following talk by Duncan Wishart and Glennn Mass (both Environment Agency) was on the same theme of the geomorphological impacts of the 2015/16 flooding in northern England. Two important points were made. First, to unpick what determines the nature of the geomorphological response and second how persistent are the changes that occur. A further point made was that there may also be the need to adapt to the geomorphological change rather than resist.

*The last such joint event was held in Lancaster in 1989 from which the book "*Floods: Hydrological, Sedimentological and Geomophological Implications*" Eds. Keith Bevan and Paul Carling was published.

The next talk was by David Sear (University of Southampton) and colleagues. Their work has shown that hotspots of geomorphic activity often occur adjacent to forms of channel and valley confinement both natural and artificial. As such, the key point was that human modifications to the floodplain and channel are critical and exercise a major control on channel adjustment.

This session was brought to a close by Jo Shanahan (Environment Agency). The role of geomorphology within the EA was initially highlighted – together the geomorphologists have over 250 years of experience! This experience is put to good use in flood risk management but Jo also suggested there is further scope in terms of adopting 'geomorphologically-informed' approaches to managing sediment and water for effective flood risk management.

The third session led with Matthew Perks of University of Newcastle demonstrating the contribution made by UAVs, with reference to an estimated 1:200 year flash flood on the Alyth Burn in Scotland. Analysis of the UAV data provided rare insight into the complexity of channel-overbank interactions during flash floods. It was suggested that such UAV data can be used to calibrate hydraulic models to inform flood defence design.

Donal Mullan (Queen's University Belfast) then moved our attention to muddy floods and the effectiveness of grass buffer strips. The efficiency of strips under climate change scenarios was modelled using the Water Erosion Prediction Project (WEPP) model. The findings indicated that present day mitigation measures may have a reduced capacity to manage muddy flooding given the changes imposed by a warming climate with enhanced hydrological change.
Last but not least Christopher Skinner (University of Hull) explained how he is modelling the geomorphic sensitivity of catchments to intense rainfall. Using a dataset from the Thinhope Burn catchment that experienced flash flooding in 2007 modelling with CAESAR-Lisflood models produced a probabilistic estimate of the relaxation time for the catchment. An aim for the future is to simulate the effects of increased storminess by reducing the recurrence interval of threshold events.

Posters specifically contri-buting to the meeting were: Fiona Thompson (University of Plymouth) Current stream power estimates for Scottish rivers and implications of climate-induced hydrological change; Baruch Avinoam (University of Loughborough) improving our understanding of flood risks through citizen science; Chris Skinner (University of Hull) Flash Flood! – a geomorphology virtual reality spectacular; Sarah Twohig (University of Loughborough) The role of sediment in managing catchment scale flood risk; Matthew Perks (University of Newcastle) Developing non-contact hydrometric monitoring networks); David Gilvear (University of Plymouth) Geomorphic assessments of two upland tributaries of the River Spey Scotland as the basis for considering river restoration; and Emma Shuttleworth (University of Manchester) Making space for water: blanket peatland restoration leads to reduced storm runoff from headwater systems.

The day ended with a 'deluge' of wine and nibbles which was enjoyed by many. Hopefully we do not have to wait another 27years for a joint BSG/BHS session!

Claire Bithall
Plymouth University

UK Hydrological Bulletin: August – October 2016

The late summer and early autumn of 2016 was characterised by rainfall and runoff patterns that were seasonally typical at the national scale but with marked regional and more local spatial contrasts, the latter often reflecting the impact of convective storms. There was a general tendency for the normal west-to-east rainfall contrasts to be accentuated and above average early autumn soil moisture deficits have delayed the seasonal recovery in runoff and recharge rates in many areas. Nonetheless, runoff at the national scale remained well within the normal range (Fig 1) and the continuing legacy of the remarkable 2015/16 winter rainfall meant that most reservoir stocks and groundwater levels across the major aquifers remained close to, or above, the normal early autumn range.

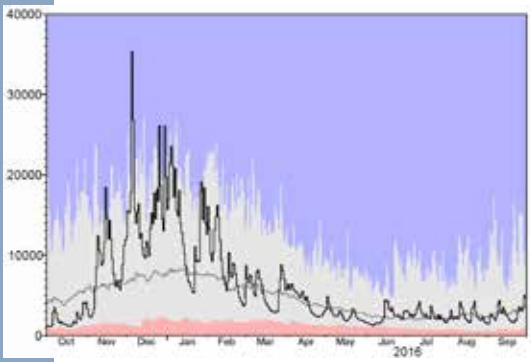

Fig. 1 Daily outflows from Great Britain (black trace) together with the pre-2016 daily average (grey trace), daily max. (blue envelope) and min. (pink envelope). Units: m^3s^{-1}

As is often the case in late summer, August rainfall totals exhibited substantial spatial variability. Much of northern England and western Scotland registered well above average monthly totals; the Lake District was particularly wet. By contrast, parts of central England and the South East, Essex particularly, recorded less than half average rainfall – extending a relatively arid episode that began in the second week of July. At Wallingford, the Centre of Ecology's Met. Station recorded its lowest July-August rainfall since 1964. Nonetheless, monthly catchment runoff totals were generally within the normal late-summer range and some notable spates were recorded.

On the 12th a Flood Warning was in operation on the river Oykel (northern Scotland) and, on the 20th, flood alerts were operating in north-west England, Yorkshire and, following a 58mm daily rainfall total at Capel Curig (Snowdonia), parts of Wales. Later in the month thunderstorms across central and eastern England generated moderate floodplain inundations and locally severe flash flooding (e.g. in Swindon where levels in the river Cole rose rapidly and the intensity of the rainfall caused Swindon Town's league match to be abandoned on the 27th). The following day, urban runoff from Luton contributed to a severe trash blockage which caused the river Lee to reach dangerously high levels.

The large late-summer spatial variations in rainfall continued into September with some western catchments (e.g. in Cornwall) reporting monthly rainfall totals >50% above average whilst parts of the extreme south east of England recorded <50%. Regional counterbalancing meant that, for the UK as a whole, the monthly total was close to the long term average and river flow patterns mostly remained well within the normal early autumn range.

Some moderate floodplain inundations did occur during the second week (e.g. in a zone from north Wales to southern Scotland where a daily rainfall total of 67.4 mm was recorded at Eskdalemuir).

More notably, very warm conditions in mid-month across southern Britain, triggered some exceptional convective storms. Overnight on the 15/16th two thunderstorms generated rainfall totals of around 70mm at Maidenhead and Brightwell-cum-Sotwell (Oxfordshire) – initial analyses indicate a return period approaching 100 years for the latter event. Local flash flooding was again common but, generally, above average early autumn soil moisture deficits moderated river flows, across the English Lowlands particularly.

They also served to delay the recovery in groundwater levels across most aquifer outcrop areas. However, the continuing benefit of last winter's remarkable recharge ensured that in most parts of the country groundwater levels remained close to, or above, average for the time of year (Fig 2), with seasonally very high levels in parts of the slow-responding Permo-Triassic sandstones of the Midlands and southern Scotland.

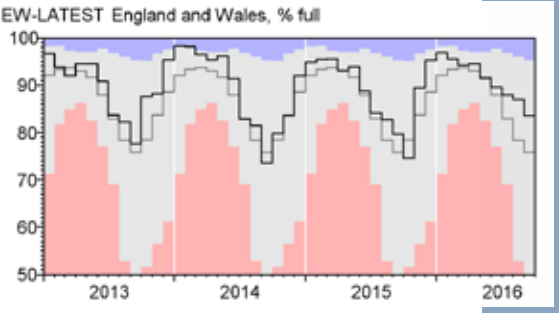

Fig. 3 Estimated end-of-month reservoir stocks for England and Wales

After a damp start in many areas, high pressure dominated synoptic patterns for most of October with precipitation confined to fog-drip in a few localities for much of the month. A short-lived cyclonic episode in mid-month brought heavy rainfall to much of England, Wales and, particularly, Northern Ireland where a 78.6 mm daily total was recorded at Killylane reservoir (near Larne) on the 14th. Correspondingly many rivers were in spate and, locally (e.g. in Belfast and Aboyne), rainfall intensities overwhelmed road drainage and sewerage capacities resulting in moderate urban flooding. Generally recessions then became re-established as Atlantic low pressure continued to be deflected to the north of the UK. With significant soil moisture deficits persisting in many areas aquifer and reservoir replenishment was again relatively modest. Fortunately, reservoir stocks across the UK – a few, mostly southern, impoundments (e.g. Ardingly) excepted – were considerably above the mid-autumn average entering October (see Fig 3) and the water resources outlook remained generally healthy.

Terry Marsh
28/10/16

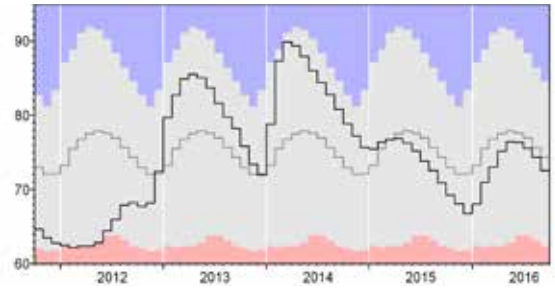

Fig. 2 Monthly groundwater levels (MaOD) in the Chalk at Stonor Park (Chilterns)

Diary

Please check our web site for major forthcoming hydrological events but in particular, note:

22nd November 2016
BHS National Meeting
UK Flood Hydrology 40 years after the Flood Studies Report
Location: CEH Wallingford
Registration online by 11.11.16 via website or direct to www.ice.org.uk/events/uk-flood-hydrology-40-years-after

3-4 May 2017
The **Peter Wolf Young Hydrolgists Symposium** will be held at the Centre for ecology and Hydrology, Wallingford.

Full details in the next issue ofCircualtion.

Editorial

Time for a new look!

And time for my routine plea for more pictures please, both for Circulation and to use on the web site. All donations greatly received and naturally credit will be given. So, if you are willing to share your pictorial gems with us, please send files to me at celia.kirby@btinternet.com

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New India-UK Water Centre

INDIA-UK Water Centre
भारत-यूके जल केन्द्र

CEH is hosting a new virtual India-UK Water Centre (IUKWC), a joint venture between the NERC and the Indian Ministry of Earth Sciences (MoES). The aim is to stimulate collaboration between the two countries and promote cooperation and collaboration between NERC – MoES water security research to establish a platform for long-term partnerships and dialogue between Indian and UK water researchers, water policy-makers and water businesses.

There will be a joint secretariat split between CEH and the Indian Institute of Tropical Meteorology, with the two organisations working on behalf of the wider research community. The centre will fund and co-ordinate a diverse programme of workshops and exchange visits, as well as promote online collaboration through social media and the centre's website.

Water researchers and stakeholders are invited to register on the IUKWC website to join the new Open Network of Water Scientists. This will ensure they are kept up-to-date with activities, funding calls, joint stakeholder workshops and are able to help shape and participate in the centre's activities.

Web links:www.iukwc.org / www.ceh.ac.uk

Front cover: Satellite image of the Ganges delta, sent via Pixabay