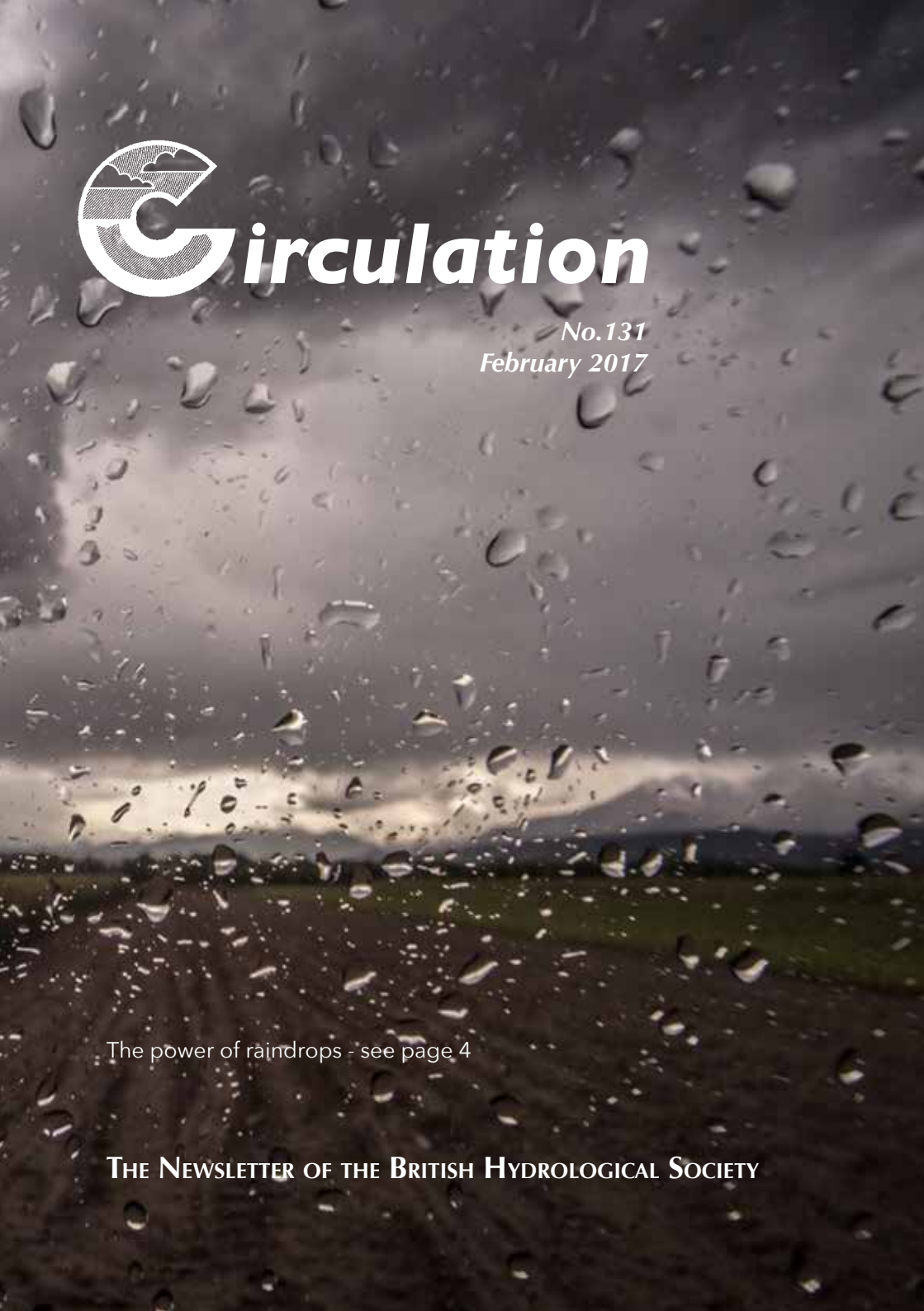


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The power of raindrops - see page 4

The Newsletter of the British Hydrological Society

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President's Piece

As we enter 2017, leaving behind Storm Desmond and friends, my attention returns to the dry rivers of southern England experiencing flows below normal and to celebrating the news from the Rivers and Fisheries Trusts of Scotland that flows along 10 miles of the River Garry, that has been essentially dry since the mid 1950s, are to be restored with benefits for salmon spawning, juvenile production and general river ecology, while minimizing the loss of hydro energy. This year our South East Section stage the first meeting on 'Drought and Agriculture in the UK' on February 2nd and then, thanks to efforts of our Midland Region, from 18th–23rd June we co-badge HydroEco 2017 – the 7th International Conference of Hydrology and Ecology – at Birmingham University.

The British Hydrological Society (BHS) was established in 1983 to foster the advancement of hydrology, to encourage good practice and scholarship in scientific and practical aspects, and to promote regional and national activities, and to support members' engagement with international developments in hydrology. In 1987 the Society registered with the Charity Commission (327488). All members of the Main Committee, elected and nominated, are 'Trustees' of the Charity with responsibilities and duties as defined at www.gov.uk. In 1990, following an agreement with the Royal Society, the BHS gained responsibility for the UK's relationship with the International Association of Hydrological Sciences (IAHS), a constituent body of the International Union of Geodesy and Geophysics (IUGG), and for administering the Exeter Fund.

Membership is being sustained at over 1000 with new student members exceeding retiring members by about 20% p.a. A recent survey (2016) suggested the BHS membership comprised mainly practitioners (52%) and academics and researchers (35%). Fifteen percent of

the members worked for the Environment Agency, SEPA or Natural Resources Wales. Traditional expertise is being sustained in catchment and flood hydrology and water resources, and the new field of hydroecology/ecohydrology is gaining momentum. Internationally, 'ecohydraulics' has also gained prominence over the past two decades with a dedicated symposia series and a new journal recently launched.

The Society retains its special relationship with its founding partners, the Centre for Ecology and Hydrology (CEH) and the Institution of Civil Engineers (ICE). Both have nominated seats on the Main Committee, the latter bridging to the ICE Water Panel. BHS is now a 'Specialist Knowledge Society' of the ICE, which provides opportunities for the Society to engage with the institution's 'Thought Leadership' programmes. On ICE's initiative, the BHS is being encouraged to seek joint meetings with the British Dams Society and the Irrigation and Water Forum (a joint meeting with the IWF on integrated urban water management is being planned for the Autumn), and also to promote engineering hydrology and to contribute to the career development of engineers. The BHS also maintains links with CIWEM through their Water Resources Panel, the UK Surface and Groundwater Archives Committee (UK SAGA) and the UK Committee for National and International Hydrology.

During 2017 the Main Committee shall bring to the Membership a revision of our statutes to reflect the outcome of the membership survey, particularly the balance between practitioners and academics/researchers. It also responds to an effectiveness survey of the Main Committee which revealed a need to clarify the membership of the Trustees, and their responsibilities, and to ensure the elected Trustees have a majority in decision making over nominated representatives on Main Committee. The revision also clarifies concessionary membership fees and the relationship between BHS and IAHS.

I look forward to meeting many of our members during 2017.

Professor Geoff Petts
President

Associate Membership of ICE

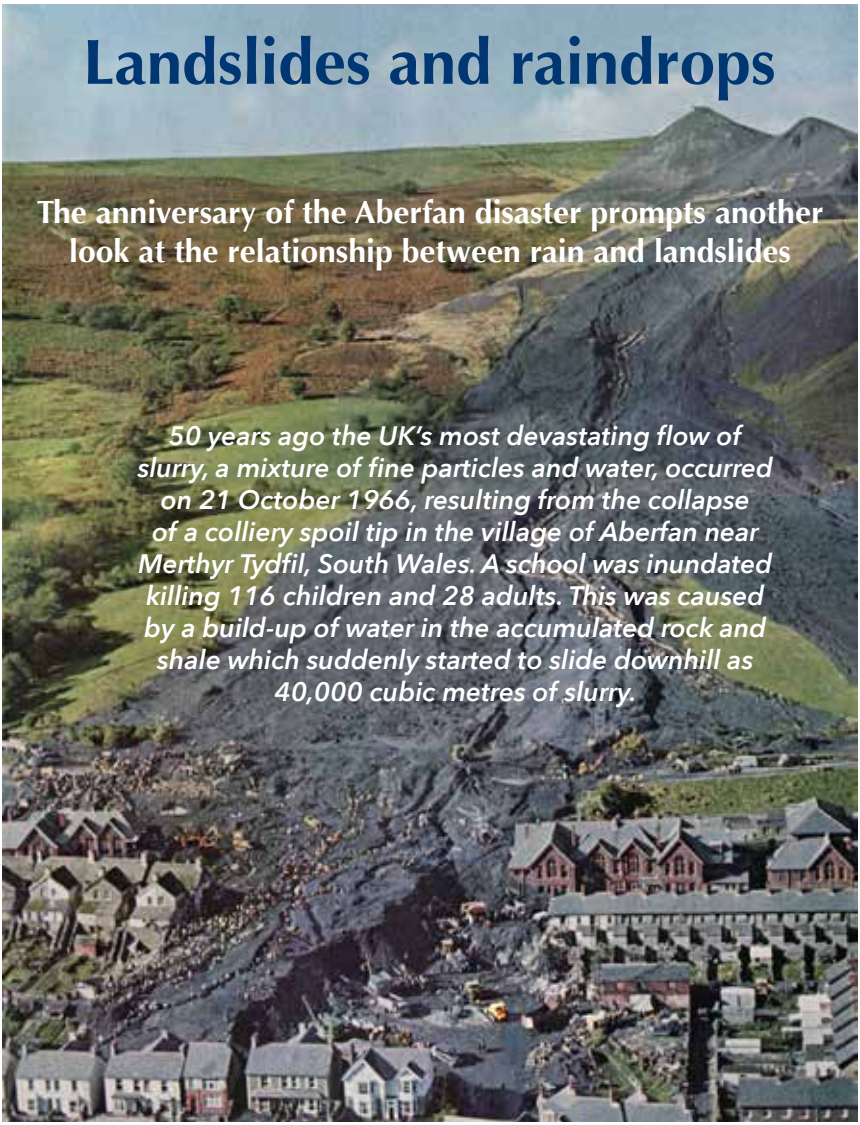
Many members have full membership of the Institution but for many more, this is not possible as they are not considered eligible. However, we have been asked to bring to your attention that there is now a new grade of membership, the Associated Membership (AMICE).

This is launched as a knowledge grade to encourage fellow professionals to develop ever-closer links.

As an ICE Specialist Knowledge Society, there is a discounted rate available. Further details on advantages, eligibility and application process are given in the formal letter from the ICE Membership Directorate which is available on the web site, under under Careers/Professional Development.

Landslides and raindrops

The anniversary of the Aberfan disaster prompts another look at the relationship between rain and landslides



50 years ago the UK's most devastating flow of slurry, a mixture of fine particles and water, occurred on 21 October 1966, resulting from the collapse of a colliery spoil tip in the village of Aberfan near Merthyr Tydfil, South Wales. A school was inundated killing 116 children and 28 adults. This was caused by a build-up of water in the accumulated rock and shale which suddenly started to slide downhill as 40,000 cubic metres of slurry.

Sheet and gully soil erosion are caused mainly by the action of water. Sheet erosion is the removal of surface soil over a large area as it moves down slopes. Gully or debris erosion is more localised where runoff is concentrated which may cause a deep channel in the land often with the movement of significant rock or mud flows. Collier and Robbins (2004) describe an example of sheet erosion in the Rio Centonara catchment near Bologna, Italy on the eastern slopes of the Apennines in April 2003. A debris flow occurred after a long period of heavy rain

in the Rest and Be Thankful pass, Scotland on 8 September 2009 which blocked the A83 main road causing a 55 mile detour.

Debris flows occur in many places worldwide, for example near Oso, Washington State, USA on 23 March 2004, in Switzerland on 18 April and 9 May 1991, and in Uttarak, Aninachal, Pradesh, India on 2 July 2016 when at least 40 people died. However, the most devastating landslide occurred 14-16 December 1999 in Vargas State, Venezuela when between 10,000 and 30,000 people died through a debris flow caused by torrential rain which produced a mud flow 3 metres deep.

Soil erosion is caused by rainfall due to raindrop impact and surface runoff. In particular, soil detachment is produced by direct incidence of raindrops on the soil surface. Wischmeier and Smith (1958) investigated rainfall kinetic energy and its relationship to soil loss. Sharma and Gupta (1989) proposed estimating soil detachment by the effect of raindrop impacts using a linear model of mass detachment per unit area, d_T where

$$d_T = k_d (e - e_o) \quad e \geq e_o \qquad (1)$$
$$d_T = 0 \quad e < e_o$$

where k_d is the detachability (erodibility) coefficient, e is the kinetic energy of the raindrop and e_o is the threshold energy required to initiate detachment. Goldman *et al.* (1986) for example suggest detachability coefficients of 0.02 for sand and 0.69 for silt.

Cerro *et al.* (1998) and others pointed out that an accurate description of raindrop mass, shape and impact velocity are required to determine the ability of raindrops to detach soil. The threshold raindrop kinetic energy needed to initiate soil detachment for medium particle size for various soils having 10^{-3} mm diameter is about 300 µJ, for 10^{-1} mm diameter is about 100 µJ, for 1mm diameter is about 200 µJ and for 5 mm is about 600 µJ (Salles et al., 2000).

Consider a typical raindrop having a 2mm diameter, a terminal velocity of 6.3 m sec^{-1} and a mass of 4 mg, then its kinetic energy is 78.3 µJ which is lower than the threshold kinetic energies given above. Hence, from equation 1, it is necessary for soil detachability to have a raindrop larger than 2 mm diameter, and have a heavier raindrop falling faster which must occur such that its kinetic energy exceeds the threshold kinetic energy.

Raindrops exceeding 8 mm in diameter were observed in the Convective Precipitation Experiment (COPE) in South Western England reported by Leon et al. (2016). The measurements were the first such observations in clouds at high latitudes. The figure below shows several drops imaged by the 2D precipitation optical array probe on-board the University of Wyoming King Air aircraft as it passed through a single cloud on 2



Images of exceptionally large raindrops from an optical array probe (OAP-2DP) onboard the UWKA, 2 August 2013
(from Leon *et al* , 2016) .

August 2013. Most of the drops are partial images (yellow background). The first drop in the sequence had a diameter of 8.4 mm.

Steiner and Smith (2000) discuss the relationship between radar reflectivity factor Z, rainfall rate R and rainfall kinetic energy flux E. They reported that

$$E = v (D_m)^2 R / 2 = 0.26 R \qquad (2)$$

where v is the terminal fall velocity of the raindrops, taken here as 0.72 m sec^{-1}. The uncertainty in this relationship was discussed, and rainfall rates related to the kinetic energy were listed. However, it should be noted that the kinetic energy – rainfall intensity formulae performance depends upon the rainfall intensity range as noted by Sempere Torres *et al* (1992) which leads to important discrepancies between them when the rainfall intensity exceeds 30 mm hr^{-1}.

For example taking Z = 20 dBz (about 1 mm hr^{-1}) the energy flux is about 0.003 Jm^{-2} sec^{-1}, and for Z = 40 dBz (about 10 mm hr^{-1}) the energy flux is about 0.22 J m^{-2} sec^{-1}. Taking 1 mm hr^{-1} as comprising around 36,891 raindrops and 10 mm hr^{-1} as comprising around 2663 raindrops then the kinetic energy for Z = 20 dBz is about 10 μJ m^{-2} and for Z = 40 dBz is about 102 μJ m^{-2}. *It is clear that rainfall rates have to be significantly greater than 10 mm hr^{-1} for detachment of medium size soil particles*. Note that in COPE rainfall rates in intense convection were observed to be often in excess of 50 dBz (50 mm hr^{-1}).

Chris. Collier
National Centre for Atmospheric Science, University of Leeds

References

Cerro, C., Bech, J., Codina, B. and Lorente, J. (1998) "Modelling rain erosivity using disdrometric techniques", Soil Sci. Soc. Amer. J., 62, 731-735.

Collier, C. G. and Robbins, G. L. (2004) "'On the assessment of flash flood impacts through the use of rainfall measurements from dual frequency microwave links and energy and water balance", in Hydrology Science and Practice for the 21st century, edited by B. Webb, N. Arnell, C. Onof, N. McIntyre, B. Gurney and C. Kirby, Volume 1, Proc. BHS Int. Conf., Imperial College, London, July, 421-424.

Goldman, S. J., Jackson, K. and Bursztynsky, T. A. (1986) "Erosion and sediment control handbook', McGraw Hill Co., New York.

Leon, D. C, French, J. R., Lasher-Trapp, S., Blyth, A.M., Abel, S.J., Ballard, S, Barrett, A, Bennett, L.J., Bower, K., Brooks, B., Brown, P., Charlton-Perez, C., Choularton, T., Clark, P., Collier, C.G., Crosier, J. , Cui, Z., Dey, S., Dufton, D., Eagle, C., Flynn, M.J., Gallagher, M., Halliwell, C., Kirsty Hanley, K., Hawkness-Smith, L., Huang, Y., Kelly, G., Kitchen, M., Korolev, A., Lean, H., Liu, Z., Marsham, J., Moser, D., Nicol, J., Norton, E.G., Plummer, D., Price, J., Ricketts, H., Roberts, N., Rosenberg, P.D., Simonin, D.,. Taylor, J.W., Warren, R., Williams, P.I., and Young, G. (2016) " The convective precipitation experiment (COPE) Investigating the Origins of Heavy Precipitation in the Southwestern United Kingdom", Bulletin American Met Soc, June, 1003-1020

Salles, C., Poesen, J. and Govers, G. (2000) "Statistical and physical analysis of soil detachment by raindrop impact: Rain erosivity indices and threshold energy", Water Resour. Res., 36, 2721-2729.

Sempere Torres, D., Salles, C., Creutin, J. D. and Delrieu, G. (1992) "Qantification of soil detachment by raindrop impact: performance of classical formulae of kinetic energy in Mediterranean storms", in Erosion and Sediment Transport Monitoring Programmes in River Basins, Proc. Oslo Symp., August, IAHS Publ No 210, 115-124.

Sharma, P. P. and Gupta, S. C. (1989) "Sand detachment by single raindrops of varying kinetic energy and momentum", Soil Sci. Soc. of Amer. J., 53, 1005-1010.

Steiner, M. and Smith, J. A. (2000) "Reflectivity, rain rate and kinetic energy flux relationships based on raindrop spectra", J. App. Met., 39, 1923-1940.

Wischmeier, W. H. and Smith, D. D. (1958) "Rainfall energy and its relationship to soil loss" Trans. Amer. Geophys. Union, 39, 285-291.

Peter Wolf Symposium 2017
Centre for Ecology & Hydrology, Wallingford
3rd-4th May 2017

This year's BHS Peter Wolf Symposium will be held at the Centre for Ecology & Hydrology, Wallingford on the 3rd and 4th May. The conference is ideal for young hydrologists and those in the early stages of their careers and creates a friendly environment and a valuable opportunity for those early in their hydrological careers to learn about other science in the field, practice their presentational skills and meet other like-minded scientists.

Wednesday 3rd May: Oral and poster presentations
Guest speakers Rob Wilby (Loughborough University) and Glenn Watts (Environment Agency) on errors in hydrological data and ensuring your hydrological research reaches decision makers, respectively. The day will close with a Symposium dinner held in Wallingford.
We welcome abstracts for oral and poster presentations.
Please send your abstract to peterwolf2017@ceh.ac.uk by 14th April 2017.

Thursday 4th May: Field visits in the area surrounding CEH.

- Tour of HR Wallingford. HR Wallingford is an independent civil engineering and environmental hydraulics organisation who deliver practical solutions to complex water-related challenges faced by their international clients.
- Talk and demonstration of the ADCP ARC-Boat, by Nick Everard (Environment Agency) down on the River Thames. The ARC-Boat represents a huge advancement of hydrological technology

Accommodation: Rates have been agreed with the Shillingford Bridge Hotel for the 3rd May – please contact them directly on 01865 858567 or reservations@shillingfordbridgehotel.co.uk quoting 'CEH Peter Wolf' for the agreed price of £85 per room per night (bed and breakfast). Please let us know if you have booked a room at the Shillingford Bridge and we will make sure we have transport available to take you to the hotel after the Symposium dinner on the 3rd May and back to CEH on the 4th May.

Deadline for Abstracts
14 April 2017
Early Bird registration
31 March 2017
Final registration
28 April 2017

www.ceh.ac.uk/get-involved/events/pws17
email peterwolf2017@ceh.ac.uk

Lucy Barker, Olivia Hitt & Steve Turner
Centre for Ecology & Hydrology,Wallingford

The BHS Early Careers Conference — and me

Are you looking for a fun and educational way to learn and share ideas, present your work in a friendly environment, and network with rising water industry professionals? One way I ticked all these boxes was by participating in the 2016 British Hydrological Society's Peter Wolf Symposium Early Career Hydrologist's Event.

If you are still wondering whether to sign up for the POW meeting, let this blog* from a last year's participant persuade you.....

***completely unsolicited - honest!**

Hosted on the green, prolific grounds of the University of Bristol, participants from far flung corners of the UK gathered for the two-day hydrology-in-action event. We came from a range of industries, from consultancies to governments trusts to academia and this was well-reflected in the rich variety of hydrology related oral and poster presentation topics. It certainly spotlighted hydrology's interconnectedness with every aspect of life and the huge potential to explore and do more in this field.

My talk focused on my experience project managing JBA RML's rural main rivers 2016 updates, which when combined with our urban main rivers, small rivers and surface water maps comprise our 30 m resolution global flood hazard maps, available in over 190 countries. These maps provide essential information for many clients, particularly in the re/insurance sector. With flooding being a year-round, ever-present crisis world-wide, clients need tools to answers questions such as, 'where do I have significant exposures in my portfolio?' and 'where can I take on new business?'. They are thus able to make informed decisions and take pre-emptive action to plan for or avoid flood-associated costs. The rural main rivers modelling targets large rivers, defined as rivers draining catchments greater than 500 km^2, in non-urbanised areas. My presentation reviewed the input data requirements and considerations, the JBA developed hydrodynamic models selected for the work, and the calculation of over 5.7 million km of river for indicative hazard maps. Also important was discussing the unique challenges of large-scale modelling, including terrain data preparation and the computation requirements for processing large, complex datasets.

To give a flavour of the other interesting work presented, I enjoyed Mhari Barnes research on foresting the uplands as a solution to reducing flood risk. Although it would seem like a straightforward solution, there were many questions to consider including how many and where to plant trees so as to have the maximum effect on flood peak? Her experiments indicated the trees had an effect on run-off but their effect on reducing the flood peak depends on antecedent conditions.

I also appreciated Ludovica Beltrame's work which I'd best describe as a fusion of biology hydrology and computer science. Her work centred on developing a mechanistic hydro-epidemiological model to simulate the risk of Liver Fluke infection and outbreaks of disease. Liver Fluke is a flat worm parasite of livestock: there is no

vaccine and there have been recent outbreaks in the UK. The risk of infection is influenced by climatic and hydrological conditions, so climate and land use change are very important factors. In her research she simulated the habitat suitability for disease development in space and time in connection with key environmental conditions.

After a full day of presentations, a bit of sight-seeing and group photo taking were organised, the highlight being a view of Bristol's Clifton Suspension Bridge. Following this, we had a three-course dinner where PhD students who participated were presented with awards for the 1st and 2nd place oral and poster presentations.

The second day was a field trip to Sheepdrove organic farm. True enough, there were many sheep in addition to the beautiful wildlife. Apart from the rustic gardens, café, and gift shop, the grounds also host the Reedbed Water Treatment System which remarkably treats all waste water from the farm, staff cottages, and office completely naturally.

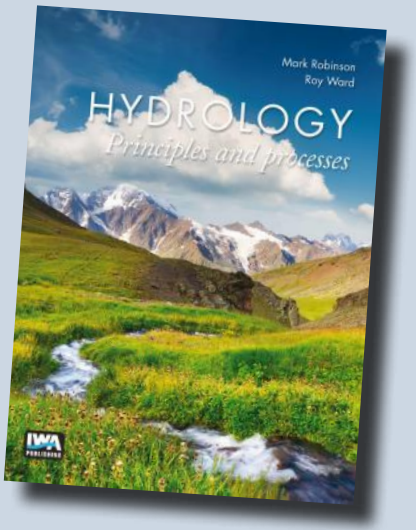
Sheepdrove is also home to ongoing university experiments and studies. One of the event organisers, Joost Iwema, explained his farm-based PhD research, which was on cosmic-ray neutron sensors and detecting soil moisture. We had a look at the equipment involved, learned some handy soil digging techniques and witnessed a long-surviving traditional way of determining soil type – by tasting it!

Altogether the BHS conference was a great experience, and I would encourage other early



career professionals to look out for it and apply. The application requires a fee for which university students are eligible for a discount and if you'd like to present your work orally, an abstract submission must be made as well.

Rebecca Alexandre



Another generous offer to BHS

We much appreciate Mark and Roy's negotiations with IWA which permit BHS members to buy this essential addition to any hydrologist's reference archive at 20% discount*

Use code BHSHYDRO20

***undercutting Amazon !**

BHS links with the International Association of Hydrological Sciences

What is IAHS?

Following an agreement made in 1990 with the Royal Society, BHS acts as the link between the British hydrological community and the International Association of Hydrological Sciences (IAHS). IAHS is a non-profit making non-governmental scientific organisation and a constituent body of the International Union of Geodesy and Geophysics (IUGG). The unique feature of IAHS is that it is a truly international forum for hydrology, run by hydrologists for hydrologists. Individual membership of IAHS is free and there are currently more than 7000 members in almost 200 countries.

The objectives of IAHS are:

1 To promote the study of hydrology as an aspect of the earth sciences and of water resources. This includes: surface and groundwaters, snow and ice, their physical, chemical and biological processes, their relation to climate and to other physical and geographical factors as well as the interrelations between them; erosion and sedimentation; the hydrological aspects of the use and management of water resources and their change under the influence of man's activities; and providing a firm scientific basis for the optimal utilisation of water resources systems, including the transfer of knowledge on planning, engineering, management and economic aspects of applied hydrology.

2 To provide a platform for discussion, comparison, and publication of research results.

3 To initiate, facilitate and coordinate research into, and investigation of, those hydrological problems which require international cooperation.

IAHS objectives are achieved principally through the activities of the 10 IAHS Commissions and through its fixed-term Working Groups. Together they organise an extensive programme of conferences and workshops. These include specialist events arranged by Commissions and Working Groups, as well as the IAHS Scientific Assembly held every four years and the General Assembly of the IUGG held every four years in between Scientific Assemblies. IAHS also interfaces with international water-related organisations, such as UN agencies and the World Meteorological Organisation (WMO), and has its own publications – *Hydrological Sciences Journal* and *Proceedings of the IAHS* (formerly the IAHS 'Red Book' series). Information about becoming a member of IAHS and about IAHS activities, Commissions, Working Groups and publications is at: http://iahs.info/

Time for clarification ?

Kate Heal, Chair, UK IAHS Committee, explains

How does the BHS-IAHS link work?

The UK link with IAHS principally takes the form of the UK Committee for IAHS, an Associate Committee of the

BHS. The Committee comprises UK-based representatives of the IAHS Commissions, the BHS President and any serving UK Officers of IAHS. It is chaired by the UK National Representative for IAHS who is nominated by the BHS President with majority support of the BHS Main Committee. The UKIAHS Chair is a full member of the BHS Main Committee. The Chair provides the UK vote at Plenary Sessions of the IAHS, is the contact for the IAHS Network of National Hydrological Associations, represents IAHS on the UK Panel for IUGG, and reports on IAHS Activities to the UK Committee for National and International Hydrology (UKCNIH). The UKCNIH aims to coordinate UK efforts in national and international hydrological and water resources management research, by promoting dialogue and collaboration between stakeholders. The membership is drawn from departments of national government, devolved governments and agencies, together with UK representatives of international non-governmental organisations and of initiatives within international programmes.

The work of the UK Committee for IAHS is conducted predominantly by email and comprises the following:

- Providing channels of communication and contact between UK hydrologists and IAHS.
- Encouraging and co-ordinating involvement of UK hydrologists in the activities of IAHS.
- Assisting in major IAHS events in the UK.
- Providing advice on IAHS matters.
- Making nominations for IAHS awards and prizes.
- Making nominations for IAHS officers.
- Ensuring that the UK discharges its voting rights in IAHS elections.

Again following the agreement between the Royal Society and the BHS in 1990, the BHS became responsible for administration of the Exeter Travel Fund. The fund arose from the income derived from investment of the profits of the First Scientific Assembly of IAHS held at Exeter University in 1982 and organised by Des Walling and colleagues. Any BHS member can apply for grants from the Exeter Fund to help with the costs of participation in the Scientific and General Assemblies of IAHS, with applications particularly encouraged from early career hydrologists.

How can I get involved with IAHS?

Individual membership of IAHS is free to anyone working in one or more field of hydrology. Join by completing the on-line form at: http://iahs.info/Members-Area/register.do

You can also get involved through:

- Participating in IAHS meetings. The next IAHS Scientific Assembly will be held in Port Elizabeth, South Africa, 10-14 July 2017. The Assembly theme is "Water and Development" and the deadline for submitting abstracts to the 26 different sessions is 14 February 2017, see: http://cwrr.ukzn.ac.za/iahs/call-for-papers/iahs-2017-in-south-africa---invitation
- Contributing to the activities of IAHS Commissions and Working Groups, including standing for Commission posts.
- Submitting papers to IAHS Publications, such as the Hydrological Sciences Journal which has a current Impact Factor of 2.182.
- Responding to the annual call through BHS for nominations of outstanding

young and mature (usually British or UK-based) hydrologists for the IAHS Tison Award and for the International Hydrology Prize respectively.

- Joining the UK Committee for IAHS as the UK representative of one of the IAHS Commissions. Currently representatives are sought for the following commissions: Coupled-Land-Atmosphere Systems, Remote Sensing, Statistical Hydrology, Tracers, Water Resources Systems. If you are interested in representing one of these commissions please contact Kate Heal, School of GeoSciences, University of Edinburgh k.heal@ed.ac.uk

For any queries about IAHS or how to get involved in IAHS-related activities feel free to contact the current Chair of the UK Committee for IAHS - Kate Heal, School of GeoSciences, University of Edinburgh **k.heal@ed.ac.uk, tel: 0131 6505420.**

Impacts from coal mine pollution on standing surface water post-restoration at St Aidan's Colliery, West Yorkshire

Due to the wide spread coal mining industry in the UK there is a large proportion of old and disused collieries, many of which have been restored using wetlands. This study was done to assess if constructed wetlands are actually effective at remediating acid mine drainage.

*We asked **Emily Pickett**, Winner of the 2016 Student Award, to share with us an account of her project, highlighting the key findings*

The St Aidans site in West Yorkshire was restored to be a 7 million cubic meter wash land, the site designed to withstand floods and host healthy habitats and ecosystems via reed beds and wet grasslands. The site was infilled with excavated land from the site itself and pumping took place to maintain low groundwater levels but this was discontinued after restoration.

Despite the restoration that took place at St Aidans, the four bodies of water showed varying signs of neutral/alkaline polluted mine drainage (pH 7.63-8.98). Negative correlations between pH and dissolved Iron suggest the rising pH causes iron to precipitate to particulate form. Considerably higher levels of Iron, Zinc and Copper were found in the sediments compared to the dissolved form; the precipitation of metals has led to sludge-like, highly metallic sediments with Zinc and Iron concentrations exceeding 1000mg/kg which is evident of extreme pollution.

This is a common result of wetland restoration and these unstable sediments need disposing of otherwise they can lead to further environmental impacts such as; reduced vegetation growth, aquatic ecosystem damage and restriction of benthic organisms. Additionally, high algal counts



St Aidan's location and sample sites



and low Nitrate levels showed unhealthy water systems across St Aidans.

This study highlighted issues relating to the evaluation of colliery restoration. There is a lack of information relating to pre-restoration water quality therefore making comprehensive evaluations of colliery restoration very difficult. Whilst we concluded that St Aidan's does not show acid mine drainage, it is hard to illustrate to what extent this is down to the restoration attempts and to what extent it is due to individual features of the site. Although post restoration testing has given insight into the water quality and spatially diverse geo-chemistry of St Aidans, it alone cannot give a comprehensive understanding of the complex processes taking place. It is important that in the future full access to pre-restoration data is given to researchers in order to fully understand how effective passive restoration is and to educate decision makers.

Emily Pickett
University of Sheffield

UK flood hydrology 40 years after the Flood Studies Report

BHS National Meeting, CEH Wallingford 22 November 2016

The focus of this one-day meeting was UK flood hydrology, past, present and future. The Flood Studies Report (FSR) was published in 1975 and, a little more than 40 years on from this, the presentations and discussions provided an opportunity to reflect on the influence the research and guidance has had on hydrological practice in the UK, Ireland and further afield.

The FSR was published in 1975 - now time to look afresh?

Max Beran, a former member of the Institute of Hydrology's Floods Team, kicked off the proceedings with "How innovative were the Flood Studies?" identifying the most innovative aspects of the research carried out during the development of the FSR. The team drew on ideas and novel analytical techniques from the statistical, rather than hydrological, literature and Max highlighted examples including innovation in data management (vast amounts of flow data and station metadata were collected and archived), the use of statistical methods to deal with relatively short time series and novel methods for flood frequency analysis based on peak-over-threshold data.

John Sutcliffe (ex Institute of Hydrology: FSR Team Leader) was the first to comment on Max's presentation, drawing attention to the importance of soil moisture deficit rather than infiltration rate in generating floods in the UK. Steve Capel-Davies (Peter Brett Associates) asked about the thought that had gone into the definition of the 10 regions and Anthony Hammond (Environment Agency) queried the methods that had preceded the FSR. Others reiterated the enormous step forward that the FSR represented in comparison to earlier recommended practice in flood frequency analysis, and hailed the magnitude of the team's achievements in an era of such limited computational capability.

The next presentation, by **Ian Littlewood** (IGL Environment), was entitled "An overview of a 1980s statutory safety inspection of a cascade of earth-embankment dam spillways: unit hydrographs then and now". Ian started by focusing on a complex hydrological case study carried out in the early 1980s to evaluate the flood safety of a cascade of three reservoirs using the (then) new FSR methods. The procedure had demonstrated the limited capacity of the spillways. Interestingly, the 10-hour probable maximum precipitation (PMP) estimate used in the assessment was 265 mm, substantially less than the total of 341 mm recorded in 24 hours at the Honister Pass during Storm Desmond in December 2015.

The second part of the presentation focused on the main differences between the computation of the unit hydrograph in FSR and in

the IHACRES model. In the subsequent discussion, David Archer (JBA) and Frank Farquharson (Water Resources Associates) mentioned similar experiences when assessing reservoir spillways using the new FSR techniques. Peter Spencer (Environment Agency) referred anyone interested in non-linear approaches to a textbook called Flood Estimation and Control by B D Richards.

David Archer (JBA Consulting and Visiting Fellow, Newcastle University) was the next to speak, on the subject of flood seasonality and the assessment of seasonal flood risk. David pointed out that the FSR and the later FEH analyses had investigated seasonality but neither offered practical guidance on estimating seasonal risk. After demonstrating the importance of considering seasonal flood risk, David then described results of applying a flexible methodology, first proposed in 1981, to recent gauge data in Northumbria.

Prompted by a comment from Paul Webster (Hydro-Logic Services), the discussion that followed focused on the importance of quantifying seasonality by the moisture state of the catchment rather than by rainfall alone, and the importance of incorporating the effects of seasonality in event-based hydrological models.

A presentation from **Andrew Black** (University of Dundee), developed jointly with **Alistair Cargil**l (SEPA), followed on the subject of Peak flow reconstruction and POT data: two ways to improve flood frequency analysis. The focus of the talk was the use of peak-over-threshold (POT) data for flood frequency analysis and the value of post-flood surveys in improving understanding of local flood processes. These approaches, coupled with flood envelope curves, were shown to reduce uncertainty and improve confidence in statistical flood estimates. In the discussion that followed, Lisa Stewart (CEH) mentioned ongoing work funded by EA on small UK catchment hydrology that has constructed a dataset of flood peaks and hydrographs. This work is also considering the value of envelope curves. Paul Webster highlighted the need to invest in gauges in small (< 25 km^2) catchments as flood estimates are often required at this scale and the FSR/FEH method development had tended to be based on medium to large-sized catchments.

Cath Sefton (CEH) started the afternoon session with The Peak Flow Data story: from FSR to NRFA and onward. Cath illustrated the evolution of the NRFA Peak Flow dataset and discussed how the programme of regular updating is leading to improvements in national data quality and consistency. Following the completion of the EA-funded FEH Local project to assess the value of local, historical and palaeoflood data and improve methods of utilizing such data, a proposal to establish a local data archive has been developed. One option would be to incorporate the new data into the existing NRFA. Mike Vaughan (Environment Agency) asked about updating text in current NRFA site descriptions and David Archer wondered whether the rate of rise data being compiled as part of the Susceptibility of catchments to INTense RAinfall and flooding (SINATRA) project might be incorporated into the NRFA in future.

Andy Young's (Wallingford HydroSolutions) presentation "From flow duration curves to flood flows: estimating QMED from flow regime descriptors" came next, describing improvements to QMED estimation in ungauged catchments. An

equation to link QMED with indices of flow regime has been developed and implemented within the latest version of WINFAP-FEH 4. Frank Farquharson asked whether short records limited their usefulness, and Andy replied that you could get useful information from only one or two years of record. Duncan Faulkner (JBA) asked about errors and Andy argued that flood estimation in ungauged catchments was improved by the use of any extra information, particularly when there is a need for practitioners to "get an answer"!

Aminul Chowdhury (WSP) was the next speaker, on "An Innovative application of FEH method in quality peak flow estimation for flood risk management" discussing problems associated with flood estimation and the importance of trying to improve poor quality data to ensure that flood risk management decisions are sound. In small catchments with few or even no data, there is a need to use what is available including any additional non-standard data that may be available.



A comment from Tim Hunt (EA) mentioned the Devon Hydrology Strategy and the attempt to improve the data available in the region. David Archer asked whether the use of historical information had been considered, to which the answer was no, although work was under way to incorporate such data into flood risk assessment.

The next presentation was "Continuous Simulation: A viable alternative to FEH for design flow estimation in permeable catchments?" by **Paul Wass** (JBA Consulting). Paul focused on the use of continuous simulation modelling in chalk catchments, combining synthetic rainfall series generated from a stochastic model with a rainfall-runoff model to derive long flow time series. The synthetic rainfall series matched depth-frequency estimates from the FEH99 rainfall model quite closely, although the long duration of the events to which such catchments are sensitive made validation difficult. Paul was asked about the uncertainties inherent in the method, to which he replied that there was still a lot of work to do to improve the overall approach. Jamie Hannaford (CEH) commented that weather generators are becoming increasingly used for both drought and flood modelling and asked how far it was sensible to push them. Paul's reply was that it was possible to develop a rainfall model that could get the seasonal/inter-seasonal component correct but that this was an area for future scientific investigation.

In the final presentation of the day, **Mike Vaughan** (EA) spoke on "Current challenges in flood estimation: an Environment Agency perspective". The aim of the talk was to stimulate discussion amongst the wider hydrological community and to seek informed comments and suggestions that would feed into the Joint FCERM R&D Programme. Mike presented a list of topics that have been identified for possible future funding including the rainfall-runoff design methodology, extreme rainfall (PMP and climate change) and long duration rainfall. The National Flood Resilience Review, undertaken following the extreme floods of the winter of 2015/16 had also identified a number of topics for improvement. Mike asked whether these topics were the right priorities with the right balance between local and national scale. He suggested that anyone interested in commenting should do so through the BHS Group in LinkedIn. A lively discussion followed with some of the key questions and comments as follows:

- Stephen Anderton (Amec Foster Wheeler) commented that he was working on the safety of new nuclear power stations, beyond normal design standards. PMP/PMF and climate change are key for this industry and are argued to be outdated. More research is needed!
- David Richardson (ex Defra) commented that the last 12–18 months, i.e. the winter of 2015/16 is a very good case study for exploring and testing new methods. We should aim to improve the prediction and understanding of such an event.
- Paul Wass and Frank Farquharson commented on the arbitrary reduction in unit hydrograph time-to-peak used in reservoir flood safety assessment based on empirical observations. There are still some fundamental hydrological science questions to be answered.
- Paul Webster asked about the baseline climate change estimate, suggesting that we need to have a robust standard based on scientific evidence rather than allowances that change with time.
- Peter Ede (Mott Macdonald/BHS President Elect) commented about water resources assessment, suggesting that baselines up to 2014 may already include 25 years of climate change.
- David Archer referred again to the SINATRA project on modelling intense rainfall and rapid response catchments. Could the results of this project be used to improve flood forecasting and flood estimation in such catchments?
- Anthony Hammond confirmed that the rate-of–rise data from the SINATRA project would be used.
- Nick Mandeville (WRA) commented that the slow flow component of the runoff hydrograph can make large difference in some catchments. IHACRES can simulate slow and quick flow. Can it be built upon?

Finally, Duncan Faulkner, chair of the afternoon session, asked what future directions research would take? Would it be national-scale modelling or more local and devolved? Will we have different methods for different places and what about more privately-funded commercial projects? These were all key topics that we as a flood community need to consider. Further discussion on this took place during a wine reception at the end of the day.

The presentations and posters from the meeting are available via the Publications pages of the BHS website.

Giuseppe Formetta, Shaun Harrigan, Lisa Stewart
Centre for Ecology & Hydrology

Reports from Travel Grant recipients

Statistics in Hydrology Workshop

Quebec City, Canada
26–27 September 2016

The seventh Statistics in Hydrology (STAHY) working group was launched in 2007 at the 25th IUGG general assembly in an attempt to bring together all the hydrologists that use statistical tools. STAHY workshop meetings have grown in size since 2008, going from bi-yearly to now yearly meetings. Hence this conference was the perfect opportunity to see what research has already been done and to present some preliminary results.

This conference attracted **James Fidal** *....."as a PhD student with research focused on urban rainfall runoff modelling and a plan to implement various statistical methods into modelling being an avenue I wish to take with my research."*

The workshop featured 42 presentations over 8 sessions, focusing on 7 different topics ranging from non-stationarity of hydrological events, advances and challenges in forecasting and time series analysis, to recent developments in copula and regional frequency analysis. Alongside the presentations was a poster session that featured 15 posters focusing on a number of different topics.

After the welcome address by Fateh Chebana, the first of the two keynote speakers was Jose D. Salas who gave a presentation on statistical analysis of hydrological processes going into great detail for both stationary and non-stationary environments. Jose D. Salas along with Jayantha Obeysekerathe won the STAHY Best Paper Award 2016 for the paper 'Revisiting the concepts of return period and risk for non-stationary hydrological extreme events'.

There then followed the first two sessions in non-stationarity of hydrological events and hydrological forecasting and time series analysis. One stand-out presentation was from Richard Vogel on the future of stochastic stream flow models, emphasing the need to understand the error in models. The third session after lunch was again on hydrological forecasting and time series analysis and was when I gave my presentation on 'Model selection techniques to assess improvements in urban rainfall-runoff modelling', in which I presented a frame-work for urban rainfall runoff modelling alongside preliminary results comparing various methods of model performance. The final session of the day focused on Copula developments in hydrology, which is a relatively new topic.

After the first days presentation's was dinner which was held at Manoir Montmorency, next to the Montmorency Falls which are approximately 84 metres high, with a suspension bridge across the fall giving a view over Quebec city.

The second day started with the second keynote speaker Vijay Singh who gave a presentation on Tsallis entropy theory for hydrological modelling. Entropy theory can be defined as a

measure of information and is gaining some attention from the hydrological community due to it having desirable properties. Vijay's presentation was very interesting sparking many discussions after the presentation and which carried on over lunch.

The first session of the second day looked into ecological and environmental hydrology, with Samah Larabi giving a presentation on applying functional data analysis to a conceptual model which involves smoothing the hydrograph to be able to analyse the high and low flows, with the derivative of the smoothed hydrograph used to determine the rise and falls of the hydrograph. The sixth session of the day was on flood frequency analysis and risk assessment, with Veronique Tremblay presenting research on applying a spatial GEV model to the estimation of extreme water levels. The seventh session concerned hydrological data assimilation, data assimilation being how observations of an actual system are incorporated into a numerical model.

The poster session then followed, with the notable contribution of Ondrej Ledvinka, exploring the performance of the generalised exponential distribution when modelling floods. With results indicating that using a GED distribution didn't perform as well as other distributions, whereas GEV distribution worked the best, it would seem that the GEV should be considered more, since Czech hydrologists use the gamma and LN3 distributions more.

For more details on publications from the conference visit the STAHY.org website. This was an enjoyable conference and I would encourage anyone in hydrology that uses statistics to attend, given the wide range of topics that are presented.

James Fidal
University of Bath

New members

Katie Bishop .....Bristol
Steven Brown .....WSP Parsons, Brinckerhoff, Basingstoke
Alex Colyer .....Imperial College London
Jacob Dearlove .....Opus International, London
Luke Farrow .....Environment Agency, Lincoln
Rebecca George .....Environment Agency, Worthing
Stephen Gibson .....Wilsham Consulting Ltd, Abingdon
Lianne Grogan .....Shipley
Charlotte Hawkins .....University of Reading
Rebecca Haw .....University of Birmingham
Matthew Hill .....University of Worcester, Reddich
Daryl Hughes .....Newcastle University
Cameron Lancaster .....Imperial College London
Josephine Nelson .....Arup, Cardiff
Christopher Rhodes .....Cambridge
Alexandra Seawell .....CH2M HILL, Peterborough
Tanu Singh .....University of Birmingham
David Tidswell .....Bradford
Doris Elise Wendt .....University of Birmingham



AGU 2016
San Francisco, USA
12–16 December 2016

Two reports from this prestigious event.

1. America's largest geography conference, with its annual gathering of ~24,000 geoscientists from a wide selection of divisions. The one relevant to me, hydrological sciences, is the largest division at AGU and proved extremely informative, diverse and progressive. This most recent meeting was the last chance to attend this international conference in its traditional home of San Francisco before it starts it tour around America (next stop = New Orleans December 2017). For me, the December 2016 AGU meeting was a fantastic chance to showcase the work from my post-doc at the University of Birmingham in an oral presentation: "Paired Catchment Analysis of the Impact of Human Activities on Hydrological Drought around the World" in the Hydrology, Society and Environmental Change: Coupled Human-Water Dynamics across Scales I session.

"I have always aimed to attend the AGU" says Sally Rangecroft

Drought is an important natural hazard, and is projected to increase in frequency and severity worldwide. However, the intertwined hydrological and social processes related to drought have only recently started to be studied. Hydrological droughts do not only have natural causes (e.g. lack of precipitation); anthropogenic activities can also alleviate, enhance or cause droughts. For example, humans abstract water from the system for irrigation and for drinking water, lowering groundwater levels, and with engineering structures such as dams changing hydrological regimes downstream. We need to develop the tools to analyse, quantify and understand the human impact on droughts worldwide and help improve water management approaches.

This research gap is what my presentation addressed. We applied a paired-catchment method (taken from flood research) and an upstream–downstream comparison to quantify the human impact on streamflow droughts across the world using observation data. Existing work looking at this is very limited, especially using observations and with a focus on drought.

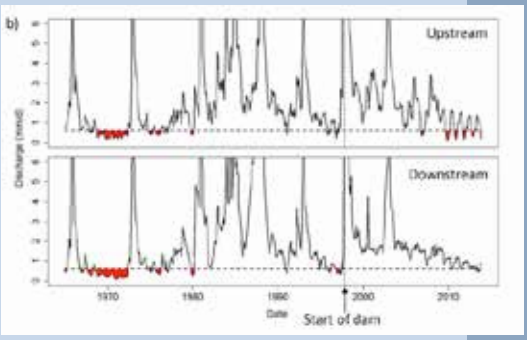
We presented a series of new case studies from UK, Australia, Chile, Mexico to cover a variety of climate and socio-economic contexts. Results demonstrated the aggravation of drought conditions (especially in deficit

volumes) with the presence of groundwater abstraction in all relevant catchments (UK, Australia), with most showing a worsening of over 100% compared to the natural situation.

These results resonate with the existing limited literature from case studies, and with the global modelli ng work that has been done. However, we found that the impact of reservoirs was seen to be mixed, dependent upon the purpose and management of the reservoir. Results from an upstream-downstream comparison in a Chilean basin showed that the introduction of a reservoir with the purpose of providing increased water security downstream, did indeed alleviate downstream droughts compared to upstream of the dam (see Figure). However, using the paired catchment approach, a case study of a reservoir in the UK operated to store and supply drinking water was shown to severely aggravate droughts downstream.

This work helps to make the step towards increased knowledge of the hydro-social cycle, especially with understanding the interlinked situation between human activities and water availability. It was extremely beneficial for me to be able to share this work with others, and to increase awareness of our work across the ocean. Furthermore, the other talks at my session were extremely enlightening and a great way to keep up to date with current research and possible collaborations.

Despite the large size of the conference, it did not feel so daunting it during the orals and



Results presented from a case study in Chile. Using the upstream-downstream comparison method, the alleviation of droughts due to the introduction of a dam can be seen.

the meeting spaces, with a c ommuni ty feel on the top floor of the Moscone conference centre (where most of the hydrology talks were). However, the poster hall was a completely different matter. There you could appreciate the sheer size of the conference (Photo 1). I was also able to present three posters on behalf of my research group who could not attend the meeting.

I also used my time at AGU to run an informal IAHS Panta Rhei working group meeting on "Drought in the Anthropocene" and update members with current activities and near future plans and workshops. I was also able to capitalise on the opportunity to meet with leaders in the relevant fields and co-authors about my current research and paper, which made a nice change from discussing ideas over email and Skype.

Of course, the trip was not ALL work. I was able to take some time either side of the conference to explore the city of San Francisco and cycle over the Golden Gate Bridge (Photo 3). I would like to thank BHS for giving me the travel grant that enabled me to attend this conference. Now it's back to data cleaning, drought analysis and paper writing from behind my desk…

Sally Rangecroft
University of Birmingham

2. On the third day of this AGU conference, I gave an oral presentation of my recent research – 'Environmental constraints on plant transpiration and the hydrological implications in a northern high latitude upland headwater catchment'. This is an experimental study in a Scots pine forest in the northeast Scottish Highland.

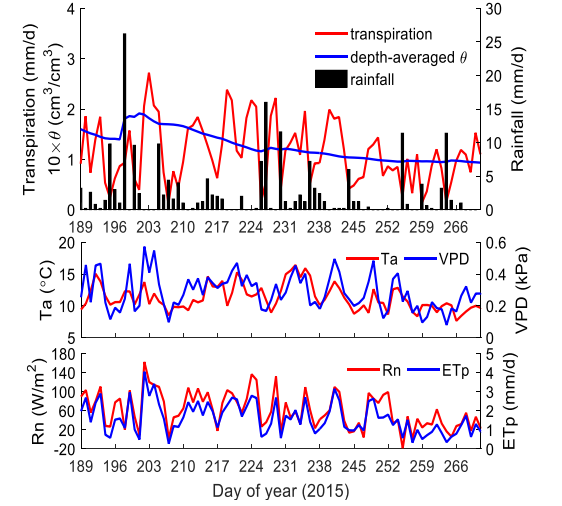
"We appreciate communications in the science community through which we exchange ideas, establish collaborations and thus advance scientific research..." says ***Hailong Wang,***

Through measurements of hydro-climate, sap flow and soil moisture, we analyzed the forest transpiration dynamics and its responses to environmental variables. In particular, we investigated the rainfall effects and soil water control on transpiration. Our results revealed that the forest transpired 47%, and intercepted 45%, of the rainfall; Scots pine re-cycled the rainwater relatively fast (within one week); water stress presents when rainfall is below 8mm/week, when trees accessed supplementary water supply from deep soils (>0.4m). Soil evaporation in the forest took only up to 10% of rainfall. My abstract can be found from AGU abstract center (paper ID: 134148).

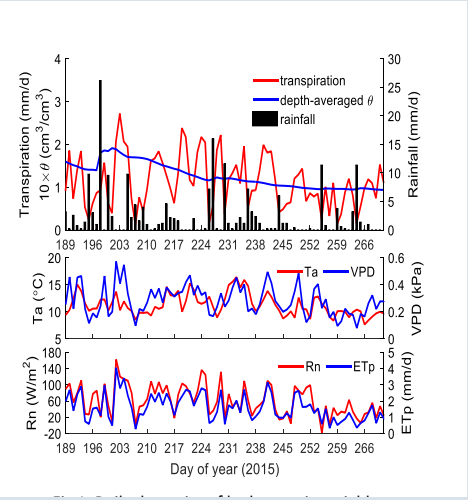
My presentation went well and I had only one question from the audience, namely about the possible reasons that the trees are not under severe water stress during dry summer time. Apart from the potential deep soil water supply during the rain-free period (we don't really have a 'dry' period), the proposed suggestion of leaf water uptake is quite interesting although not verified at our site.

I also had a chance to meet with some people who work in Ecohydrology, such as Prof. Enrique Vivoni at Arizona State University, and Dr Mohammad Safeeq at the University of California, Merced: their expertise inspired me to explore upcoming research directions and provided the opportunity for future collaborate.

The most exciting thing for me during the conference was the Langbein lecture, this year given by Prof. James Kirchner from ETH, Zurich. I enjoyed the reference to watershed travel times and hydrological responses inferred from chemical, isotopic and hydrometric time series. Also the many new insights to understanding



Daily dynamics of hydrometric variables



Mean hourly rainall effects on trans-piration (upper panel); effects on rainfall classes on transpiration over the study period (lower panel).

hydrological processes under climate impacts and terrain effects, and the many state-of-the-art techniques to track water cycling in the soil-plant-atmosphere continuum.

I believe the 2016 AGU was a success to all attendants, including me. Back from the conference, I will continue my research and think about some inspirations from other participants for future work.

Hailong Wang
School of Geosciences
University of Aberdeen

Travel grants

Travel grants are awarded from the Society's general funds to help BHS members whose travel expenses to attend scientific meetings are not met by an employer. .Indeed, a fair chunk of many issues of *Circulation* are devoted to the reports from lucky recipients. At ths time in the international conference calendar, we anticipate a sizeable demand for funds to attend the EGU meeting in April. We have already put a warning on the web site that applications needed to be in NOW so if you haven't already done so, get your forms in straightaway.

As noted in Kate Heal's article on our links with IAHS (page 10) our other source of grant money is the Exeter Travel Fund so those of you who are attracted by the IAHS Assembly in Port Elizabeth, South Africa, need to note the imminent date for abstracts AND that BHS will need applications to this grant by **28th April 2017**. There will be more alerts on this in due course.

To apply, use the form at *www. hydrology.org.uk/about_awards.htm* or contact **Claire Samuel**, CH2M Hill, Burderop Park, Swindon SN4 0QD *(tel: 01793 816430, email: claire.samuel@ch2m.com*

*full details are given on the Society's web site



FLOODrisk 2016
Lyon, France
17 – 21 October 2016

FLOODrisk 2016, the third European Conference on Flood Risk Management, brought together researchers, policy makers and practitioners from across the world to share latest progress and findings about flood risk research, policy and management practice. With 232 oral presentations and papers, and 70 posters, this event follows the successful FLOODrisk 2008 and 2012 conferences, held in Oxford (UK) and Rotterdam (Netherlands) respectively. The next conference will take place in Budapest (Hungary) in 2020.

A unique feature of the FLOODrisk conferences (organised every four years) has been the positive mix of universities, NGOs, research centres and companies, at international level to create a really vibrant and inspirational context, including 30 exhibition stands and parallel events.
An example of parallel activities was the Young Professional Reception and Dinner, supported by Deltares. This included a networking game, 'Hazards & Measures'. The objective was to develop a flood preparedness plan for the Bagmati River basin (Nepal), using limited information and resources. Given that a group of experienced professionals was invited, it was an excellent opportunity for Young Investigators to find inspirational figures among them.

I presented my paper 'Disruption and adaptation of urban transport networks from flooding' in the 'Critical infrastructure and cascading impacts' session. This one, chaired by Bob Bedhun, HDR, included also three presentations from the EU project INTACT (Andrew Tagg, HR Wallingford; Kees van Ruiten and Karin de Brujin, Deltares) about a methodological framework for assessing infrastructure vulnerability and resilience of European protection measures.
Violette Gallet, CEPRI (Centre European of Prevention of Risk Inundation) discussed the vulnerability of critical lifelines such as energy, waste and water, transport, telecoms during floods.

Prof. Damien Serre, University of Avignon talked about the interdependency of critical infrastructure in the context of cities as complex "systems of systems", discussing urban resilience alongside resistance, absorption and recovery capacity.

Dr Gianluca Pescaroli, IRDR (Institute for Risk Disaster Reduction) of UCL

Maria Pregnolato *represented the School of Civil Engineering and Geosciences of Newcastle University, together with Claire Walsh and supervisor Richard Dawson.*

(University College London) highlighted the need for updating the Flood Directive, focusing on the flexibility of preparedness and adaptation. His study is part of the FORTRESS (Foresight Tools for Responding to cascading effects in a crisis) project, coordinated by Prof. David Alexander.

Finally, my talk presented a case study based on Newcastle city, which demonstrates the potential benefit that the introduction of green infrastructure could have on minimising disruption to road transport infrastructure. Transport networks underpin economic activity by enabling the movement of goods and people, but they are highly vulnerable to extreme weather events such as flash flooding due to intense precipitation. Existing approaches to assess the disruptive impact of flooding on road transport fail to capture the interactions between floodwater and the transport system, typically assuming a road is fully operational or fully blocked, which is not supported by observations. In the paper, a new function that relates the depth of flooding to vehicle speed and disruption was presented, vital for appraising the benefits of road drainage and flood management schemes. The study is linked to the FP7 RAMSES project, which aims to deliver quantified evidence of the impacts of climate change and the costs and benefits of a wide range of adaptation measures.

The presentation of my research aroused the interest of many in the audience. In particular, I discussed the potential of extending my methodology to another case study with Dr Ian Pattison from Loughborough University. A further application of the method to emergency, evacuation planning and accessibility was also discussed with Dr Nicola Rebora (CIMA Foundation, Italy) and Silvia De Angeli (IUSS Pavia/CIMA Foundation, Italy), and Dr Daniela Molinari (POLIMI Milano, Italy).

The work was also of interest to flood managers seeking to understand the risk of flooding on road transport. Indeed, the depth-disruption function presented in the paper could enable transport planners and policy makers to more realistically represent cost disruption in transport scheme appraisal, providing a significant advance on existing practice. As an example, I was approached by Barry Hankin, JBA to apply this function in a study of flood risk on England's strategic road network.

I am delighted that my presentation was awarded a commendation in the Best Early Career Author Award. The presentation of the paper "Disruption and adaptation of urban transport networks from flooding",can be found at: **http://prezi.com/7q1rxdorz2tz/?utm_campaign=share&utm_medium=copy.**

Overall, a key and reoccurring message from the event was that hard flood defences are no longer the only option for effective flood risk management; both structural and non-structural measures of prevention, mitigation and adaptation should be incorporated. Working with nature is the next challenge, aiming to create a link between the EU Flood Directive 2007/60/EC and the EU Water Framework Directive. Another important point was that social media could be exploited for flood event management and for data gathering. Past events are very relevant, especially the recent ones, and best-practice should learn from them to improve models. Lastly, an increasing social science component is advocated in the integration of decision-making and risk assessment, looking for an improvement

in engineering science as a socio-technical issue.

Finally yet importantly, Lyon is a UNESCO World Heritage Site for its historical and architectural landmarks: it is a fabulous city! It played a significant role in the history of cinema (Lumière brothers invented the cinematograph in Lyon), and the city is also known for its famous light festival, Fête des Lumières, which occurs In December.

I am extremely grateful to BHS for the support that allowed me to attend this significant conference. The event provided me the chance to share the main outcomes of my research with an international audience and to receive insights from researchers and professionals from the most important institutions.

Maria Pregnolato
Newcastle University

"As an academician in the Civil Engineering department of Universiti Putra Malaysia as well as an early career scientist, I was thrilled and excited to learn from the range of different scientific and management approaches of flood risk management offered during my one-day participation at the conference" says Balqis Mohamed Rehan

My paper on 'Uncertainty and sensitivity analysis of flood risk management decisions based on stationary and nonstationary model choices' was accepted for oral presentation under the sub-theme of 'Policy-appraisal investment planning and decision making tools'. The study is part of my PhD research, which I completed in August 2016 from the University of Oxford. The paper seeks to understand and explore the implications of climate change and variability on the behaviour of flood protection decisions and also the economic consequences of these decisions. Quantitative evidence of the relative decisions' behaviour resulting from conflicting model choices in flood protection decision making were explored with emphasis on stationary and nonstationary statistical models. In order to achieve these objectives, a decision analysis framework was developed.

Decision makers' conflicting behaviours when deciding upon flood protection with different assumptions about the influence of climate change to the flood frequency were simulated; a risk-based approach was adopted within the framework, to establish robustness. Aligned with the current advancement of nonstationary extreme value distribution models in representing the effects of anthropogenic climate change upon hydrological extremes, the models were used in both simulating the decision makers' model choice pertaining to change and also in simulating the 'real' world scenarios, in addition to the conventional stationary model. The study captures findings in terms of economic indicators (i.e. benefit of average annual damage reduction and net present value) that will be insightful in improving real world decision making (Figure 1).

Some of the talks that I managed to listen to are the following. Engineer Celine Trmal (CEREMA, France) presented a paper on using GIS software in detecting flood protection

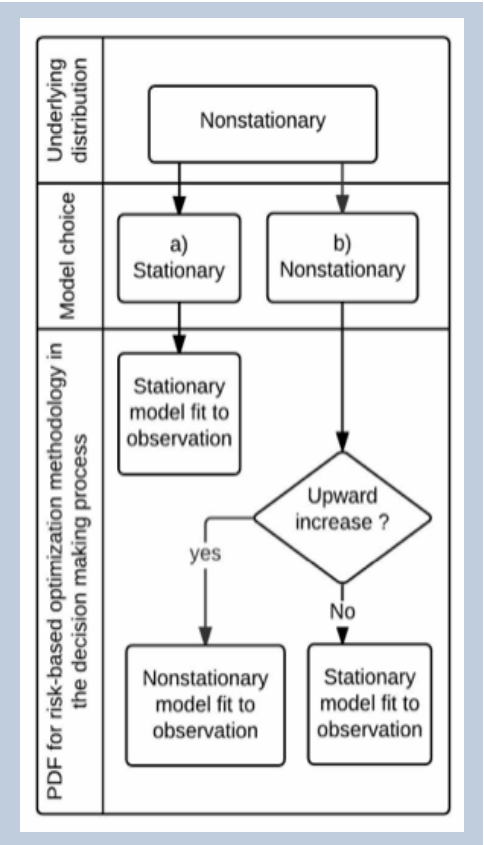


Fig 1. Part of the simulation study is the assignment of the state of the underlying distribution (i.e. nonstationary), the model chosen by decision makers, and the final model applied by the decision makers in the risk-based optimization methodology.

structures, in particular the availability of high-resolution LiDAR DTM. The approach suggested allows the footprints of the structures as well as the crest levels to be identified and established on flood prone area maps, which can then be used in scenario analysis of flood propagation. Professor Giuseppe T. Aronica (University of Messina, Italy) presented work on exposure-vulnerability matrices in flood risk assessment. A 2D hydraulic model was used together with a micro-scale damage assessment to obtain vulnerability curves of a number of elements at risk. Using field surveys and Google Street, they identified the location of assets in their case study. This approach, although it does not provide quantitative estimation of risk, offers matrices of indicator as a way to summarise the relative condition of the considered elements at risk.

An interesting talk by Prof. Jochen Schanze (Technische Universitat Dresden, Denmark) provides new insights on how resilience can be defined for flood risk management. His talk 'Resilience in flood risk management – exploring its added value for science and practice' distinguishes the concept of resilience between a subject concerning construction (or more specifically flood protection) and a subject concerning risk management strategies. The former is typically used in a quantitative way to represent the degree to which refurbishment is needed for recovery from flood impact, with no remaining damage, as an indication of maximum resilience, whilst the criteria determining resilience in risk management strategies adopts an analytical approach to describe organisational behaviour.

Apart from talks on technical assessments and theoretical perspectives around flood risk management, I also came to learn about some of the current, present and on-going flood risk management strategies of countries across Europe. A very interesting talk was given by Prof. Frans Klijn (Deltares, Netherlands) on 'Implementing new flood protection standards: obstacles to adaptive management and

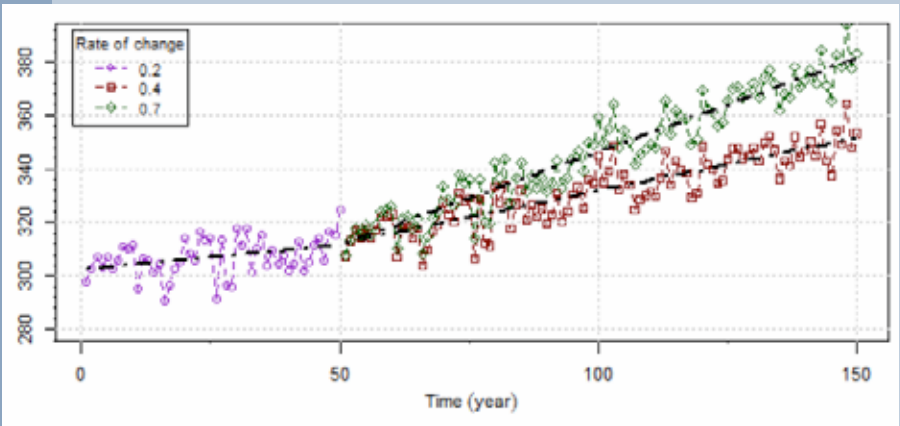


Figure 2: Different trends of mean of annual maxima flows associated with time with varying imposed annual rate of change in a GEV nonstationary model: Purple plots were generated from an underlying rate of change of 0.2, red plots with an underlying rate of change of 0.4 and green plots with an underlying rate of change of 0.7.

how to overcome these'. He started off by providing the background to the on-going revision of the Netherlands' flood risk management policy and continued by highlighting several challenges and obstacles they are currently facing. Some of the popular approaches that can be adopted as a decision tool (i.e. adaptive pathways, robust decision making and least regret options) were also discussed.

There are also presentations on coastal flood risk management: Agnes Cabal (ARTELIA Water and Environment, France) discussed long term coastal submersion and flood management plans; Marc Igigabel (France) talked on 'coastal flood protection systems – concepts and analysis'; David Wyncoll (HR Wallingford, UK) on the 'Spatial analysis and simulation of extreme coastal flooding scenarios for national-scale emergency planning' and Dr Oscar Ferreira (University of Algarve, Portugal) on a framework to identify coastal hotspots for storm impacts. All papers presented at the conference are reachable through E3S Web of Conferences 7.

I was so very engrossed in attending as many presentations as I could, as well as catching up with the latest information from the exhibitions, that I forgot to snap any pictures during the conference. Although I am thus quite disappointed, I am glad to learn that the FLOODrisk 2016 conference committee has made available a large collection of photos during the conference, available from: http://floodrisk2016.net/news/survey-photos-and-proceedings/.

Overall, I am left determined to initiate more research and improve flood risk management in my country. I look forward to attending FLOODrisk conference 2020 and encourage young researchers on flood risk management studies to also attend. I can assure you that it is absolutely worth it.

Balqis Mohamed Rehan
Department of Civil Engineering
Universiti Putra Malaysia,

Evapotranspiration — Friend or Foe?

In ***Circulation 130*** I tried to draw attention to the threat that, if UKCP09 is right, future increases in evapotranspiration (ET) will soon exceed all abstractions put together. And rising. ET of course occurs through plant stomata, and I called them "invisible thieves".

In ***Circulation 131*** James Dent asks whether I meant that "something should be done to control these evil stomata!"

Nice one, James, but no, not quite. The 'evil stomata' do indeed 'steal' huge amounts of water, but they use it to grow most of our food and all of our green environment. We need them. They need water. The questions are: how much? and where from?

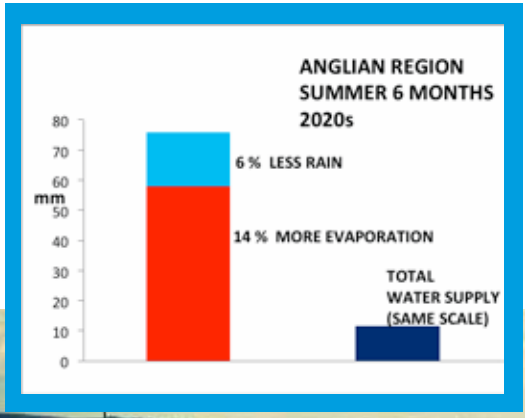
But James hits the nail on the head when he calls ET "the neglected component of the hydrological cycle" because it "often falls into the too-hard category". Could that be why even hydrologists seem oblivious to the 'dry-side' implications of climate change?

Here is that simplistic diagram again:

The block on the right is non-consumptive, but receiving much attention (demand management, abstraction licensing review etc). The block on the left is total potential loss, but receiving almost no attention. True, it hasn't happened yet - but why are we fiddling with relative trivia while Rome is predicted to burn?

Shouldn't we be looking at the bigger issues that are going to hit us if our summers really do get hotter and drier?

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Predicted additional desiccation (UKCP09 central projections)



UK Hydrological Bulletin: November 2016 – January 2017

For much of the country the November 2016–January 2017 period provided an extreme contrast with the extensive and protracted flooding a year earlier. Some floodplain inundations did occur in late November but, generally, the last three months have been characterised by modest rainfall, seasonally high soil moisture deficits and correspondingly delayed recoveries in river flows, reservoir stocks and groundwater levels. By late January runoff rates were seasonally depressed over wide areas, with particularly low river flows across southern England. Water resources in most parts of the UK are resilient to single dry winters and most reservoir stocks remain well above drought minima but a wet late winter and early spring is needed to replenish stocks and trigger a belated recovery in groundwater levels – particularly in the south.

For the UK as a whole the November rainfall was close to average but very unevenly distributed in both a spatial and temporal context. Scotland registered around 70% of average –contributing to its driest October–November since 1962 – whilst England reported appreciably above average rainfall, the bulk being associated with the passage of Storm Angus (on the 20th) and a second deep low pressure system in its wake. In Devon, rainfall accumulations of 96 mm in 48 hrs were recorded in Exeter whilst Dunkeswell registered 107mm in 72 hrs. By the 22nd, flood warnings were extensive across England, south Wales and extending into southern Scotland. However, this wet interlude failed to herald a general recovery in runoff (and recharge) rates across the country). Steep river flow recessions became established in the fourth week and end-of-November outflows from England as a whole were substantially below average for the time of year (Fig 1).

In relation to groundwater resources the picture was more complex. Whilst aquifer recharge through the autumn had generally been modest, the residual benefits of successive wet winters meant that groundwater levels in most index wells and boreholes remained within the normal range at month-end.

December was notably mild particularly in northern areas and, much of Scotland aside, it was a largely dry month with particularly arid conditions experienced across southern England where many catchments registered less than a third of their monthly average rainfall; in London some localities reported monthly totals of only 10 mm. River flows were correspondingly depressed. A substantial proportion of rivers across southern England, including

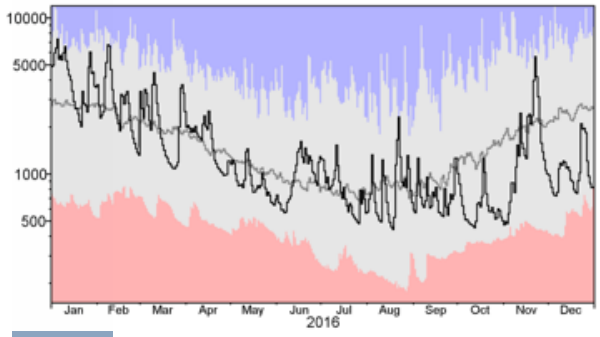


Fig 1 Daily outflows from England (black trace) together with the long term daily average (grey trace), daily max. (blue envelope) and min. (pink envelope). Units m^3s^{-1}

the Taw (Devon), Stour (Dorset) and Medway (Kent) reported new December runoff minima and total outflows from England were close to the lowest on record for the end of the year (in a series from 1961 – see Fig 1). Correspondingly, reservoir stocks were mostly well below average and, for England and Wales as a whole, end-of-year stocks were the lowest since 2003 (Fig 2) albeit well above the minima registered in 1989 and 1995. Particularly low late-December stocks were reported for Wimbleball reservoir (Somerset) and the, much smaller, Ardingly reservoir (West Sussex); stocks were also depleted in many farm reservoirs. With seasonally high soil moisture deficits across most aquifer outcrop areas, groundwater recharge was also very restricted during December. As a result, groundwater levels in most fast-responding aquifer units were notably low at year end. For the Compton House well in West Sussex the depressed December levels (Fig 3) would be expected, on average, only once every 10–15 years.

The first half of January was mild and unsettled, with cyclonic conditions predominating. Western and northern Scotland was particularly wet with significant snow accumulations on high ground. There was significant rainfall in southern England also. On the 13th the passage of a deep low pressure system triggered a tidal surge along England's east coast and brought heavy rainfall to many parts of the country. A daily rainfall total of 41.2 mm was recorded at Bournemouth and fluvial flood alerts were in

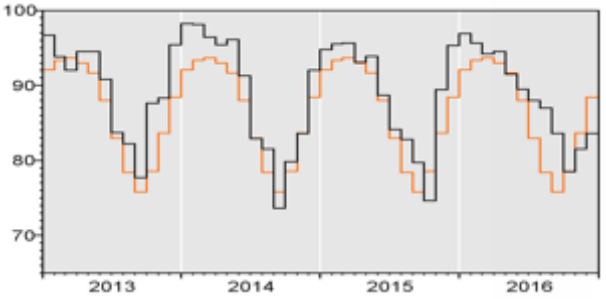


Fig 2 Estimated overall reservoir stocks for England & Wales (% of capacity); the black trace shows the end of month stocks, the orangetrace is the long term average

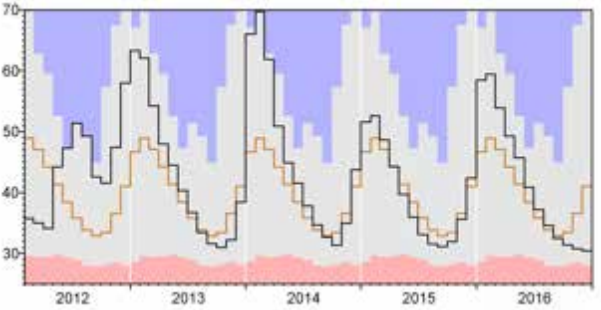


Fig 3 Monthly groundwater levels at Compton House (black trace) together with the long term monthly average (orange trace), monthly max. (blue envelope) and min. (pink envelope)

operation in a few responsive southern rivers (including the Tamar and Wey). After the 17th however, high pressure dominated synoptic patterns across most of the UK, accompanied by very low temperatures and meagre precipitation – largely restricted to fog-drip in some southern, central and eastern areas. With soil moisture deficits across the English Lowlands in early January being more typical of May, a general recovery in runoff and recharge rates was still awaited and flows in many groundwater-fed streams (e.g. the Itchen and Lambourn) have changed little since those reported in the late summer of 2016. Some drought stress may be anticipated if rainfall through the late winter and early spring remains appreciably below average.

Terry Marsh
26/1/2017

Diary

Please check our web site for major forthcoming hydrological events and further details

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.

30 March 2017
GROUNDWATER 2017
Brownfield Briefing's annual Groundwater conference , central London.

10-13 April 2017
WRaH 2017
Weather Radar for Hydrological Prediction and Water Management: 25 years of Progress and Emerging Challenges
Korea University in Seoul, Republic of Korea.

23-28 April 2017
EGU General Assembly
Groundwater - Surface Water interactions: biogeochemical and ecological processes
http://meetingorganizer.copernicus.org/EGU2017

18-23 June 2017
HydroEco 2017
Ecohydrology on the edge: ecology-hydrology-human interactions in a changing world"
http://www.birmingham.ac.uk/generic/hydroeco2017/index.aspx

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