Circulation

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Iguaçu Falls, Brazil, March 2013

for full story, see page 3

MSc Studentship Funding Competition 2013

Students considering staying at university for a Masters degree are having increasing difficulties with funding which is no doubt leading to hard choices. Research Council sources have dried up and employers have more and more calls on limited funds. If BHS is to live up to its commitment to help future hydrologists, it is essential to find some financial support for the current generation of post-graduates. The Society has thus set up a Studentship Funding Competition – now in its third year – to provide a small number of studentships ~£1000 towards the costs of the Masters degree (MSc/MRes only) tuition costs at a UK Higher Education Institution.

Application forms and full details of candidate eligibility can be downloaded from the British Hydrological Society website at http://www.hydrology.org.uk/

Complete applications should be emailed to d.lumbroso@hrwallingford.com. No postal applications will be accepted.

Deadline for submission of completed applications is

9 August 2013.

Editorial

This is rather a short newsletter this time. This is presumably because the period between New Year and Easter is a bit sparse on meetings so there has been relatively little to report.

We are continuing with our series on specialist hydrological research and teaching groups that have been set up in recent years. This time, it is the group at Newcastle, the WRSRL which originated as a NERC-funded group back in the 80s (intially with a 'shelf-life' of 15 years, if my memory is correct!).

You see that we are running the Studentship scheme again this year and hope to be able to help a few more of the next generation BHS members. An interesting aspect of hydrological education has been thrown up by John Mosedale who, prompted by Bob's comments in the last issue, has asked the unthinkable: WHY is there no first degree in hydrology? We have discussed this possibility at the last Committee meeting and are keen to take the concept further. More comments would be welcome from members.

Celia Kirby

Simulating the flood inundation dynamics of tropical South American floodplains

As a PhD student researching the inundation dynamics of the Amazon floodplain, it was always one of my hopes to be able to travel to South America and other parts of the world as part of my studies. So far I had been very fortunate in being able to attend two AGU conferences (including one in Hawaii) as well as conduct field work at my Amazon floodplain study site. I was therefore extremely fortunate to get another travel opportunity, this time to visit two university research groups in Brazil, for a total of one month in March 2013.

I would spend the first two weeks of my visit working with Prof. Adriano Rolim da Paz at the Federal University of Paraíba in the city of João Pessoa, the most easterly city of Brazil (Fig. 1). My second fortnight would be spent visiting Prof. Walter Collischonn and his group at the Institute of Hydraulic Research (the Portuguese acronym being IPH), based at the Federal University of Rio Grande do Sul in Porto Alegre in the south of Brazil. The overall research aim during my visit was to develop hydrodynamic models of tropical floodplain environments in South America. The flood inundation dynamics of such settings often play a crucial ecological function but current understanding of these dynamics is too poor to assess the impact of future pressures from both societal development and climate change.

At João Pessoa, Prof. Adriano da Paz's research focused on the floodplain of the Pantanal, situated in the upper Paraguay River basin covering an area of 140 000 km^2 across Mato Grosso do Sul state in Brazil and the eastern flank of Paraguay and Bolivia (Fig. 1). This area experiences an annual floodwave which inundates the vast majority of the area and then drains during the dry season. Such inundation dynamics promote a huge biodiversity which has led to the area being designated as a UNESCO world heritage site. However, increased human pressures from cattle ranching and dam building threaten to disrupt these inundation dynamics, yet the precise nature of this disruption is not understood due to the poor understanding of the present conditions.

To address this research need, Prof. Paz had previously developed the SIRIPLAN modelling framework which coupled the treatment of catchment processes, using the MGB-IPH model developed by Prof. Collishonn at IPH, with the treatment of floodplain hydraulics from the LISFLOOD-FP model developed by my supervisor Prof. Paul Bates at Bristol University.

One of the broader objectives of our research collaboration was to update the LISFLOOD-FP component of this framework using the latest work from the hydrology group at Bristol. Prof. Paz had already visited the group in June 2012 where he implemented the new inertial equation from LISFLOOD-FP into the framework. This enabled greater stable model time steps as well as representing more of the physics of floodplain flow which is especially important in settings, such as the Pantanal, with shallow water surface slopes.

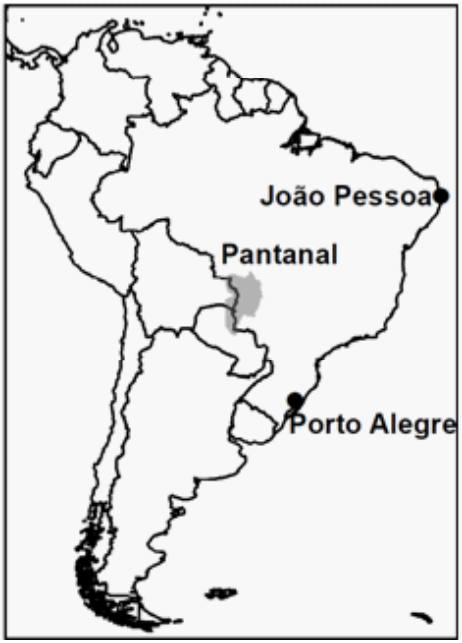


Fig 1 *Location of Pantanal wetland (shown in grey)*

My objective during my visit was to apply some of the Digital Elevation Model (DEM) processing methods that I had developed for my PhD in the Amazon. The DEM is used to represent topography in the floodplain but for remote tropical basins such as the Amazon and the Pantanal the only available dataset (from the Shuttle Radar Topography Mission – SRTM – flown in February 2000) is subject to errors induced by the vegetation canopy which can significantly degrade the accuracy of any model simulation. Typically, this is caused by the vegetation canopy preventing the DEM measurement sensor from reaching the bottom of the canopy; consequently the resulting DEM will reflect an elevation within the canopy. To overcome this I simply subtract a given percentage of a vegetation height, obtained from a global dataset produced by the NASA Jet Propulsion Laboratory, and then apply a smoothing filter to reduce random noise errors. In the Amazon this approach greatly improved the accuracy of my simulations, but in the Pantanal I noticed that it resulted in the DEM being lowered by too much. On further inspection I attributed this to the different vegetation properties between the Amazon and the Pantanal. In the former the canopy is tall and dense whilst the latter has shorter vegetation which is less dense; consequently, this possibly enabled the SRTM sensor to measure the bareground elevation. This proved to be quite a useful test for me in finding how applicable, and indeed how necessary, such a vegetation correction is to other remote forested floodplains.

Aside from my own research, during my time at the university in João Pessoa I was impressed at the level of engagement between undergraduates and the research undertaken by academic staff. Prof. Paz introduced me to two of his students who had been really interested in his lectures on urban flooding and wanted to do more research on the topic. Consequently they and Prof. Paz drew up a research proposal to investigate urban flooding in Porto Alegre, Brazil where rapid urbanisation had meant this had become a serious problem. They were awarded funding from the university to provide a bursary for the students to work on the project for a set number of hours per week over the course of the previous year. Their results highlighted particular drains which significantly contributed to urban flooding and in April this year they presented their findings at a national academic conference. In addition to their results, they had also learnt valuable research skills, including coding in Fortran which will likely provide invaluable for their future studies. I should point out that all of this work was in addition to their course studies, it did not form any formal part of their course.

For the last two weeks of my visit I was based at the Institute of Hydraulic Research (IPH in Portuguese) in Porto Alegre in the south of Brazil. The IPH is one of the largest institutes of its kind in South America, established in 1953 and designated a UNESCO centre of hydraulic research in the 1960s. This enabled the construction of many impressive research facilities including two large buildings consisting of scale model flumes, the appearance of which was similar to the photograph of the facilities at Wallingford which featured on the front cover of February's edition of Circulation. I was at the IPH to visit Prof. Collischonn who had developed the MGB-IPH hydrological model which has been applied to numerous basins across South America. Prof. Collischonn and his group were in the process of training staff at the Brazilian national water agency to use the MGB-IPH model across all of Brazil. Training the staff in using the MGB-IPH model was helped by the development of its graphical user interface which was embedded within the free to use MapWindow GIS program; this had been coded by one of Prof. Collischonn's PhD students.

Specifically, I was interested in the application of the MGB-IPH model to the entire Amazon basin by another of Prof. Collischonn's PhD students. It is possible that water inputs into the Amazon floodplain from local hydrological sources can play an important role in the inundation dynamics of the floodplain. To investigate this I took MGB-IPH predictions of local hydrological water inputs at all of the large lakes situated on the periphery of my Amazon study site (Fig. 2) and coupled this with LISFLOOD-FP predictions of flood inundation from the main Amazon river. The initial results showed that the hydrological water inputs were important for maintaining a flow connection between the main river channel and the floodplain. This increased connection could assist with the drainage of the floodplain during floodwave recession. I am also interested in how local hydrological

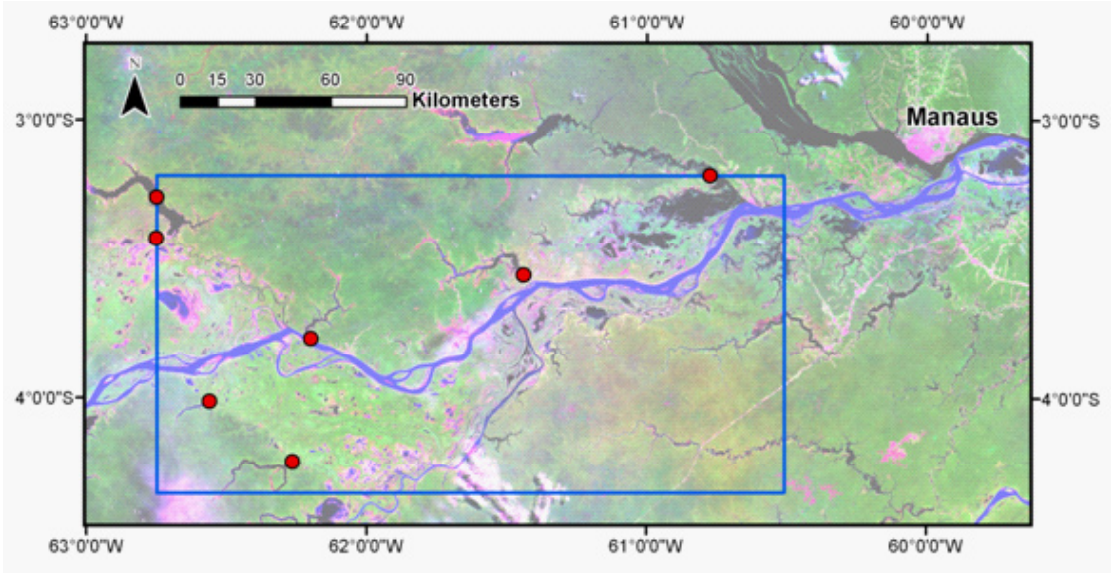


Fig 2 *Location of the 7 local flow inputs (red dots) into my Amazon floodplain study domain (blue rectangle).*

flow inputs influence floodplain flow directions during the course of the annual floodwave. During my fieldwork in the Amazon in 2011 I observed how flow directions could change, possibly based on the timings of water from the main river channel and local inputs. Therefore my current work is investigating the results from the original simulation in order to extract flow directions at different times over the floodwave and assess whether the changes in flow direction are attributable to local hydrological flow inputs.

Overall, my research visit to Brazil was extremely useful for my PhD research as it gave me the opportunity to test some of my methods in a different study site and to add further detail to my studies of the Amazon floodplain. Naturally, I also took the opportunity to do some sight-seeing during my free time, including a visit to the magnificent Iguaçu Falls (fron cover) and a quick visit to the Itaipu dam as well.

The research on the Pantanal forms part of a longer term research collaboration between the University of Bristol and the two universities in Brazil. The next stage of this research is to use the newly revised modelling framework to investigate the impact of upstream dam building upon the inundation dynamics of the Pantanal floodplain. I would like to acknowledge the Royal Society for funding my research visit through a Foreign Exchanges Grant awarded jointly to my supervisor Prof. Paul Bates and to Prof. Walter Collischonn.

Calum Baugh
School of Geographical Sciences, University of Bristol

Register of Consultants

No doubt a sign of the times, but we have received a steady trickle of enquiries from people looking for hydrological consultancy, picked up from the 'Resources' page on the BHS web site. These requests are usually in connection with flood risk analysis. If any members are considering 'going it alone' may we suggest that an entry in our Consultants Register may prove a useful route to potential clients.

Water Resource Systems Research Laboratory (WRSRL) Newcastle University

WRSRL is the home of a dynamic and diverse group of hydrologists, hydraulicians and water engineers in the School of Civil Engineering and Geosciences at Newcastle University. A wide ranging research programme covers catchment modelling, climate and extremes, and a wider context of Earth Systems Engineering. We welcome collaborative research proposals from research and technical institutions world-wide and encourage applications from high calibre students for taught courses and research degrees who wish to build their expertise in a leading international research environment.

Background

WRSRL has delivered research and postgraduate teaching since 1985 and is now arguably the largest engineering hydrology group in the UK, with 11 academics, 15 research associates and fellows, 26 PhD students and a research income for 2008–2012 of over £9M. There are five chairs in the group: **Chris Kilsby** (Hydrology and Climate Change and Director of WRSRL), **Richard Dawson** (Earth Systems Engineering and Director of CESER), **Hayley Fowler** (Climate Change Impacts), and **Enda O'Connell** (Water Resources Engineering). Prof Dr. Ing. **Andras Bardossy** joins WRSRL in May 2013 as Professor of Earth Systems Modelling.

WRSRL's research activities concern catchments, climate and extremes, and the wider related needs of society, such as infrastructure and cities. The research is executed with advanced hydroinformatics, risk analysis and decision support tools. Computational and statistical research is backed by a long-term commitment to field experimentation at a range of scales, which provides the data necessary to pioneer process understanding and underpin model validation. Scientific achievements have been converted into tools to transform industry practice and our system-scale perspective is shaping the policy agenda.

Research themes

Catchment modelling has been a strength of the group from its birth, when the SHETRAN physically-based distributed modelling system was developed, adding capabilities in sediment and contaminant transport to a comprehensive coupled 3-D surface-groundwater model. Modern computers and data resources have revolutionised SHETRAN's capabilities and it is now freely available with an easy to use set-up procedure at http://research.ncl.ac.uk/shetran/. As well as applications by 200 users in 20 countries, SHETRAN has been applied worldwide at Newcastle including UK (200 catchments), France, Italy, Iberia (Tagus-Guadiana-Douro basins), South America, China (Yangtze to Three Gorges Dam) and Indonesia. Uses include land use and climate change impacts, forestry studies, flood and drought risk estimation, diffuse pollution in surface and groundwater, erosion and sediment transport, and transport of radio-active nuclides.

Hydrological extremes form another major theme, where stochastic rainfall models (such as Rainsim) have been developed since the early 1990s and used in flood risk and drought modelling. WRSRL joined the Willis Research Network in 2011 and is now developing flood risk estimation capabilities for very large areas (UK and whole Danube). A range of shock-capturing 2-D hydrodynamic models (CityCat, DASH) have been developed for use in fluvial, urban drainage and tsunami applications. Very high resolution computational domains (e.g. whole cities at 1 m resolution) are now simulated using GPU arrays in-house or the Cloud. These models will be used for analysis of flooding from intense rainfall in a new NERC project (SINATRA). Hydrological measurement programmes and direct interventions have been pioneered for rural flood management and diffuse pollution control in the DEFRA

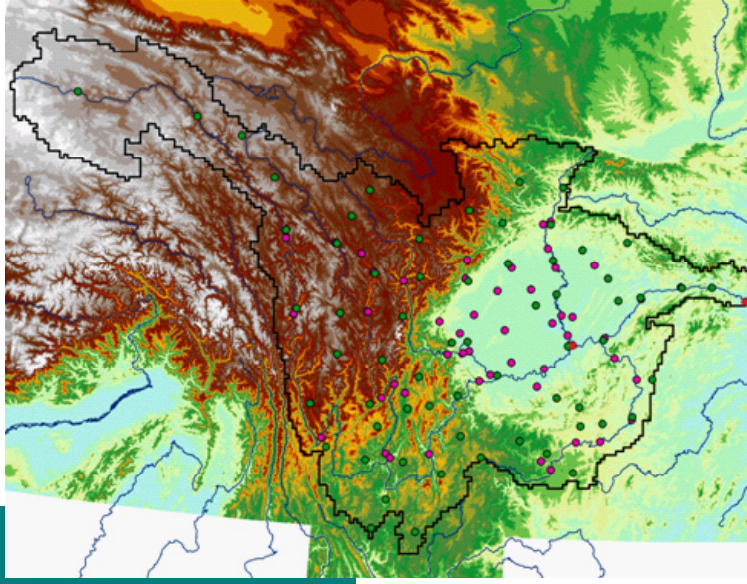


Fig 1
The Yangtze catchment, China to the Three Gorges Dam showing elevations and weather monitoring stations

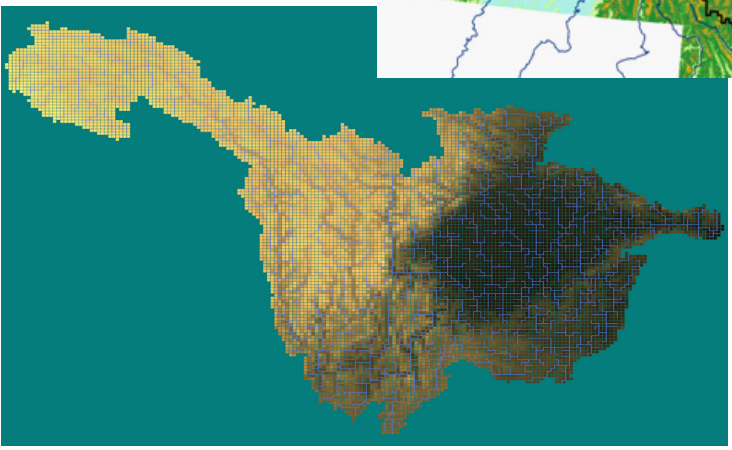


Fig 2
The SHETRAN 3D computational domain of the catchment area

Demonstration Test Catchment programme in the Eden basin, Cumbria, that builds on a multi-scale hydrological monitoring programme started in 2000. Further experimental facilities are located at University Farms at Nafferton (diffuse pollution management) and Cockle Park (borehole array) and a hydraulics and hydrology laboratory equipped with a range of flumes for research and teaching.

Climate change scenarios and impact assessments have been developed for more than 20 years with downscaling climate model outputs a major aspect. Combination with stochastic rainfall models has resulted in the UKCP09 weather generator developed at Newcastle, which now has a spatial version for regional use in the ARCADIA project providing spatial fields of rainfall, temperature and PET for urban and catchment scale impact assessment. The weather generator technology is now being transferred to the Caribbean, USA, Pakistan and Germany. An emergent research direction is to use high-resolution (1.5 km) climate models to understand how convective storms may change in the future (NERC CONVEX).

Earth Systems Engineering (ESE) recognises that water is not a stand-alone topic but requires a holistic approach that considers interactions between physical, natural and social systems. This was initially addressed through integrated river basin management approaches but the paradigm has now been developed to include research on cities, infrastructure networks and impacts of global change. WRSRL contributes

to a University Research Centre in ESE research, CESER (http://www.ncl.ac.uk/ceser). Water-related ESE work includes national water resource system modelling (EPSRC Infrastructure Transition Research Consortium), leadership of the new EPSRC/ESRC I-BUILD Centre that is developing new business models for infrastructure, and development of the Tyndall Centre Urban Integrated Assessment Facility that has coupled analysis of land use change, climate impacts and greenhouse gas emissions to provide policy relevant information to support climate sensitive design of cities and their infrastructure. Close to home, extreme rainfall events in Newcastle in summer 2012 have led to a close collaboration with the city council to collate urban flooding observations using 'crowd-sourcing' techniques and to consider city-wide adaptation measures to alleviate similar events in future. (http://ceg-morpethflood.ncl.ac.uk/toonflood/).

Global context

In addition to many UK activities, WRSRL research reaches worldwide. Projects address forestry, land use and flooding issues in South America, including the Iwokrama programme in the Guyana rain forest, forestry in Chile and floods in Ecuador. Water resource management experience includes study of the West Bank aquifer and Iran, as well as testing a Decision Support System for the whole Nile basin. Climate change poses particular threats in the Himalaya, so a Leverhulme study is addressing snow and glacier changes in the Upper Indus. Remote regions are data sparse, so we have developed methods jointly with Geomatics colleagues, particularly in pioneering river level and discharge measurements using satellite altimetry, demonstrated in the river Mekong and now being applied worldwide.

Teaching

MSc provision is research led and quantitatively based and consists of professionally accredited programmes in Hydrology and Climate Change, Hydrogeology and Water Management, Hydroinformatics and Water Management and Flood Risk Management: see http://www.ncl.ac.uk/ceg/study/postgraduate/taught/ for details. These programmes are offered as 1-year residential, or part-time Flexible Learning programmes. Students are drawn from a wide international base as well as the UK, and a particular highlight is the Erasmus Mundus Euro Aquae programme offered jointly with three other European Universities. The courses are driven by industry requirements and graduates are in high demand throughout the UK and internationally in the water industry (consultancy and utilities), regulatory agencies and academia.

Recent publications

Bathurst, J.C., Amezaga, J. *et al*., 2010. Forests and floods in Latin America: science, management, policy and the EPIC FORCE project. *Water International* http://dx.doi.org/10.1080/02508061003660714

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Burton, A., Kilsby, C.G., Fowler, H.J., Cowpertwait, P.S.P., O'Connell, P.E. 2008. RainSim: A spatial-temporal stochastic rainfall modelling system. *Environ. Mod. Soft*., **23**(12), 1356–1369.

Dawson, R.J. *et al.*, 2011. Assessing the effectiveness of non-structural flood management measures in the Thames Estuary under conditions of socio-economic and environmental change. *Glob. Environ.Change*, **21**(2), 628–646.

Dawson, R.J., Peppe, R. and Wang, M. 2011. An agent based model for risk-based flood incident management. *Natural Hazards*, **59**(1),167–189, doi: 10.1007/s11069-011-9745-4.

Ewen, J., O'Donnell, G.M., Bulygina, N., Ballard, C., O'Connell, E. 2013. Towards understanding links between rural land management and the catchment flood hydrograph. *Quart. J. Roy. Meteorol. Soc*. **139**, 671,350–357.

Glenis, V., McGough, A.S., Kutija, V. *et al*. 2013. Flood modelling for cities using Cloud computing. J. Cloud Computing: Adv.s, Syst. Applications. **2**(7), 18.

Hewett, C.J.M., Quinn, P.F. *et al.* 2009. A multi-scale framework for strategic management of diffuse pollution. *Environ. Mod. Softw*., http://dx.doi.org/10.1016/j.envsoft.2008.05.006

Jones, M.R., Fowler, H.J., Kilsby, C.G, Blenkinsop, S. 2012. An assessment of changes in seasonal and annual extreme rainfall in the UK between 1961–2009. I*nt. J. Climatol*. In press.

Kilsby, C.G. *et al*. 2007 A daily weather generator for use in climate change studies. *Environ. Mod. Soft*., **22**(12), 1705–1719.

Liang, Q., Borthwick, A.G.L. 2009. Adaptive quadtree simulation of shallow flows with wet-dry

fronts over complex topography. *Computers & Fluids*, doi: 10.1016/j.compfluid.2008.02.008

Serinaldi, F., Kilsby, C.G. 2013. A modular class of multisite monthly rainfall generators for water resource management and impact studies. *J. Hydrol*. 2012, 464–465.

Publications on the web

More progress with updating the web site has included scanning and uploading past issues of *Circulation*. We are now up to (or back to) Issue No. 51, August 1996 — only another 50 to do!. To compile a proper index is a daunting task but as a first step, there is now a 'Contents' file which lists articles in alphabetical order which you can search by key word and/or author if known. Probably a touch of the rose-tinted spectacles were in operation when compiling the list, but it did seem that earlier articles were more 'meaty' than nowadays and do form an impressive repository of British hydrological information.

We have been publishing BHS Conference proceedings electronically since 2008 and these are available on our Publications page as well as through the DOI facility. We now propose to scan the print copies of the earlier events, reference copies of which are held by the CEH and ICE Libraries, so that these too may be accessed through the web site.

Editor

Dear Editor

BSc Hydrology

In the last edition of Circulation, the President said you can only really study hydrology as a graduate. This is true, but it should not be. If I were studying civil engineering, for example, I would not have to wait until my fourth year to study engineering. So it should be for hydrology.

There should be an undergraduate BSc course for hydrology. This may be difficult, because the MSc courses are often linked to Civil Engineering departments, who may not be best placed to deliver an undergraduate course. For example, many engineers I have worked with might discuss at length the relatively errors in their hydraulic models, yet be blissfully unaware of the large errors in the estimates of flood peaks they are modelling.

In my experience, hydrology takes input from all the earth sciences; and without that underpinning knowledge, it is difficult to properly master the principles of hydrology. And that training, that synthesis of earth sciences, is what allows hydrologists to see the bigger picture in environmental matters. Perhaps at last hydrology can take it's place as a proper 'ology' in the UK.

Yours sincerely

John Mosedale



This picture, one of the entries from our photo competition last year, seems to nicely capture April's weather: I wonder how appropriate it will be by the time of the next issue of Circulation.....*?*

Changing Extremes in Hydrology

Exeter College, Oxford, was the elegant venue hosting this one-day conference organised by Hydro-GIS. Attended by over 70 delegates from at least 30 organisations, including budding hydrologists from Icknield Community College, it was a focused and interest-filled day complete with tea on the college lawn and lunch a la Hogwarts in the college dining room. It was particularly enjoyable to immerse ourselves in such a specific set of flood events as those seen in 2012, which we all witnessed from different perspectives, and to bring together discussion and understanding from varying angles.

Starting proceedings, **Mike Kendon** (Met Office) discussed the rainfall patterns from 2010 to 2012 that culminated in groundwater recharge failure in the winter of 2011/12, and a very dry first three months of 2012. He went on to highlight some of the impacts of the drought and suggested the public perception of the drought was masked by the rainfall and flooding that followed throughout the remainder of 2012.

Following Mike, **Simon Parry** (CEH Wallingford) presented more detailed data on 2012 rainfall, recounting how totals up until March 2012 were about 76% of average but sustained rainfall throughout the summer eradicated the soil moisture deficits. He also related that whilst rapid terminations of droughts are not rare, 2012 was unusual because it took place over the summer. **Stuart Hyslop** (EA) then followed, explaining some of the challenges presented by a drought when managing stakeholders with diverse interests such as recreation and farming, providing examples of management measures undertaken along the River Thames.

During the second session we heard from **Tim Hess** (Cranfield University) about the problems extreme weather can bring for farmers – from lower yields due to soil waterlogging to increased production costs when animal fodder is drought- or flood-damaged. The consequences are not only financial, as there is growing evidence that the prolonged difficulty for farmers is also having a social impact.

Social media cropped up in **Edmund Penning-Rowsell**'s (Flood Hazard Research Centre) discussion of overall flood risk in England and Wales, as he explained how geo-located Twitter messages could be used to identify flood hotspots. Edmund also compared flood damages from major events since 1947, and regretted that currently there is no systematic analysis undertaken of different losses from major events such as those seen in 2012. This type of analysis could be useful in identifying the best ways to spend Defra's flood defence budget.





After lunch we heard a fascinating account of the link between climate change and the response from the geosphere from **Bill McGuire** (UCL). A significant consequence of climate change appears

to be the reduction in pressure on existing geological faults as overlying ice sheets melt, and the lithosphere rebounds, allowing volcanic eruptions, earthquakes and tsunamis. The message from Bill was clear: climate change is going to result in geological mayhem!

Bruno Mertz (GFZ, Germany), using an example from the Mekong, talked us through the difference between detecting a change in flood hazard (whether it be frequency or magnitude) and attributing that change to a driver. A great deal more work will be required on the latter to separate their effects and understand their linkages.

In a final session before the drinks reception, **Patrick McSharry** (Oxford University) and **Thomas Kjeldson** (CEH Wallingford) discussed some statistical aspects of flood hydrology. Patrick has an innovative method for improving confidence in risk estimates using data reanalysis, while Thomas (perhaps taking up Bruno's challenge?) has investigated whether trends in urban flood records can be attributed to climate change and land use drivers.

Rounding off the day **Harvey Rodda** (Hydro-GIS Ltd) highlighted some of the ways that flood risk maps and data have been mis-used, either deliberately or perhaps through ignorance.

Altogether this was a refreshing and educational meeting, benefitting from being focussed on a hydrologically outstanding year. These last words are from the Icknield College students, who said "It was a fantastic day — the lectures were absolutely amazing and we learnt a huge amount about the extreme weather the UK has faced since 2010, and the impact climate change looks set to have on geological hazards and agriculture"

The head and the Geography department were extremely grateful for the opportunity to take GCSE students to a professional event and maybe this is something to be encouraged in order to inspire our future scientists?

Vicky Shackle and Clare Gardner, JBA Consulting.

New members

Lauriane Allard.....MWH UK Ltd, Solihull
Majed Alsubih.....Heriot Watt University
Lisa Bannister.....Pontypool
Kaltoum Belhassan.....Blatley
Mike Bell.....Reading University
Janice Blanc.....Heriot Watt University
Ciaran Broderick.....Republic of Ireland
Olivia Burns.....Wallingford Hydro Solutions, Stirling
Dan Cadman.....Apem Ltd, Stockport
Andrew Calcutt.....Dunmow, Essex
Paul Campbell.....AMEC Environment & Infrastructure UK Ltd, Northwich
Leonie Clitherow.....Birmingham University
Laura Crossley.....University of Liverpool
Mark Dutton.....Environmental Measurements Ltd, Tyne & Wear
Victoria Finch.....Atkins, London
Sarah Halliday.....Reading University
Andy Hardstaff.....Hertfordshire County Council, Watford
Jennifer Anne Hornsby.....Shipley
Andrew House.....CEH Wallingford
Francesca Hurt.....AMEC Environment & Infrastructure UK Ltd, London
James Knightbridge.....Mott MacDonald Group Cambridge
Xi Liu.....Imperial College London
Ally Martin.....Richard Allitt Associates Ltd, Haywards Heath
Grace Marion Martin.....United Utilities, Manchester
Peter William Metcalfe.....Lancaster University, Kendall
Helen Claire Montgomery.....Pell Frischmann, Exeter
Karen Moss.....Cascade Consulting, Manchester
Caroline Mullen.....CEH Wallingford
Susana Ochoa Rodriguez.....Imperial College London
Michael Deering...Pollock Environmental Measurements Ltd, Tyne & Wear
Stephanie Pullan.....Cranfield University
Jonathan Ritson.....Imperial College London
Matthew Sharp.....University of Sheffield
Andrew Sheerman-Chase.....Independent Consultant, Ashford, Kent
Kathryn Smith.....The Canal & River Trust, Warwick
Lindsay Todman..Imperial College, Stratford-upon-Avon

UK Hydrological Bulletin: February – April 2013

The February–April period was dominated for long periods by winds from the north-east quadrant, resulting in very cold conditions with snow forming a significant component of precipitation totals across much of the country. The three months saw exceptionally wide variations in river flows, with widespread flood warnings at the beginning of February but depressed runoff rates in responsive rivers during March and substantial rainfall deficiencies in parts of Scotland. Nonetheless, the general water resources outlook was healthy entering April — in southern Britain a dramatic contrast with 12 months ago.

Weather patterns during the final week of January were very cyclonic with successive frontal systems bringing abundant rainfall across much of the country. With snowmelt augmenting runoff from saturated catchments, February began with total outflows from Britain close to the highest on record for the time of year. Flood warnings were very extensive as a further episode of flows at, or above, bankfull served oince again to underline the importance of floodplains as natural conduits for excess runoff.

February precipitation totals fell below 50% in parts of central Scotland and although the high proportion of snow (which normally implies an appreciable underestimation of total precipitation) makes for some uncertainty, it was very probably the driest month at the national scale since March 2012. Blizzard conditions were common in northern Britain during the first week and considerable snowfall extended down to parts of southern England on the 10/11th. By mid-month, spate conditions were extensive and flood alerts were in operation in all regions of England & Wales. Thereafter however the weather remained cold and largely dry; Oxford reported a rainfall total of less than 1 mm over the last 17 days of the month.

With many catchments frozen, river flow recessions in impermeable catchments were notably steep and previous late-February flow minima were closely matched in a number of very responsive rivers draining steep upland catchments (e.g. the Luss Water which drains into Loch Lomond). At the same time however, abundant outflows from springs and seepages contributed to a continuing high risk of groundwater flooding (e.g. in Dorset and the Berkshire Downs).

Notwithstanding the modest February precipitation, more than three-quarters of the index reservoirs across the UK were within 5% of capacity at month-end and groundwater resources were also very healthy, reflecting the outstanding recharge rates maintained throughout much of the latter half of 2012. The water resources outlook entering the spring was thus very healthy across most of the UK — parts of northern and western Scotland being the exception.

Synoptic patterns in March were again dominantly anticyclonic and the persistence of a bitter easterly airflow was reflected in the coldest March for the UK since 1962. Exceptional early spring snowfall, often associated with high winds was very disruptive across most of the country (Guernsey Airport was closed by snowfall on the 11th). Early in the third week an Atlantic frontal system abutting against cold continental air to the east resulted in widespread and heavy snowfalls with considerable damage, transport disruption and temporary power loss. Precipitation totals for the month were modestly above average across most of southern Britain but again meagre in parts of Scotland. The Highland Region registered its lowest February–March precipitation since 1975 and soil moisture deficits for the end of March were the second highest on record — the exceptionally dry soil conditions (for the early spring) were a contributory factor in a number of wildfire outbreaks (e.g. near Fort William). Soil temperatures, which rarely reached 6°C during March, were generally too low for crop growth, adding to the agricultural stress associated with livestock management in the freezing conditions – many sheep perished.

Some spring-fed streams and rivers aside, March runoff totals were seasonally depressed. Estimated March outflows from Scotland were the lowest in a series from 1961 with

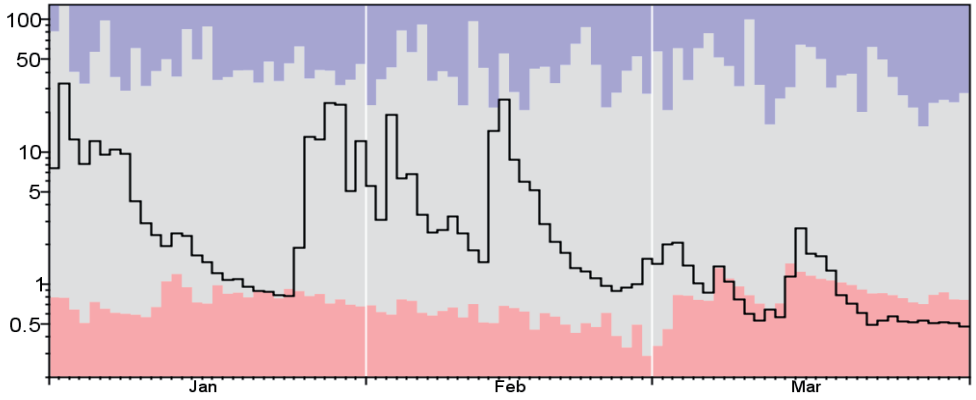


Fig 1 *Daily mean flows (m^3s^{-1}) for the River Nevis at Claggan; pre-2013 daily max. and min. flows are represented by the blue and pink envelopes*

extremely low flows reported for some Highland rivers (see Figure 1). For both Northern Ireland and Wales, 2013 was the fifth year in succession to register modest March runoff totals (see Figure 2). Correspondingly, overall reservoir stocks declined appreciably through the early spring, and more steeply in reservoirs where planned maintenance programmes were in operation. Early April stocks were generally in the normal seasonal range but considerably below average in parts of north-west Britain — however meltwaters from the substantial upland snow cover boosted inflows as temperatures slowly increased through April. The gradual thaw was beneficial in relation to flood risk during April but a series of active Atlantic frontal systems brought pulses of heavy rainfall to western and northern areas in the third week — again triggering widespread spate conditions.

The late winter and early spring of 2012/13 have seen brisk declines in groundwater levels in responsive aquifers (e.g. in the Carboniferous limestone in Derbyshire) but early spring levels in most index boreholes remained within, or above, the normal range — with notably high levels characterising much of the central and eastern Chalk outcrops. Many groundwater flood alerts were still extant in April and high level springs were flowing very strongly (e.g. in the Chilterns and Berkshire Downs). The complexity of groundwater level responses to periods of rainfall excess or deficiency is well illustrated by the hydrograph for the Heathlanes borehole in the Permo-Triassic sandstones outcrop in Shropshire (Figure 3). Despite the record rainfall in 2012, the time taken for surface infiltration to descend through

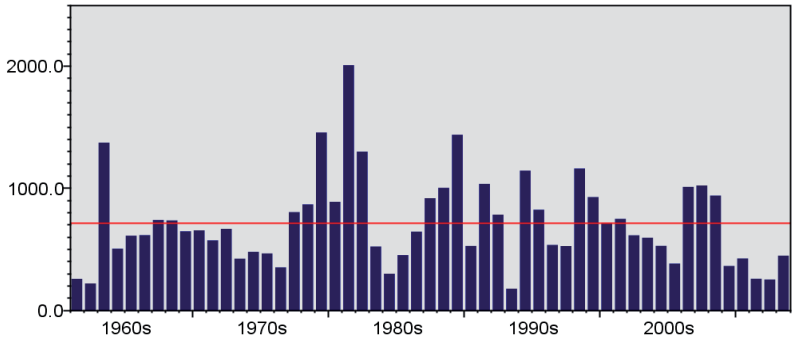


Fig 2 *Estimated average March outflows from Wales (in m^3s^{-1}); the red line is the long term average*

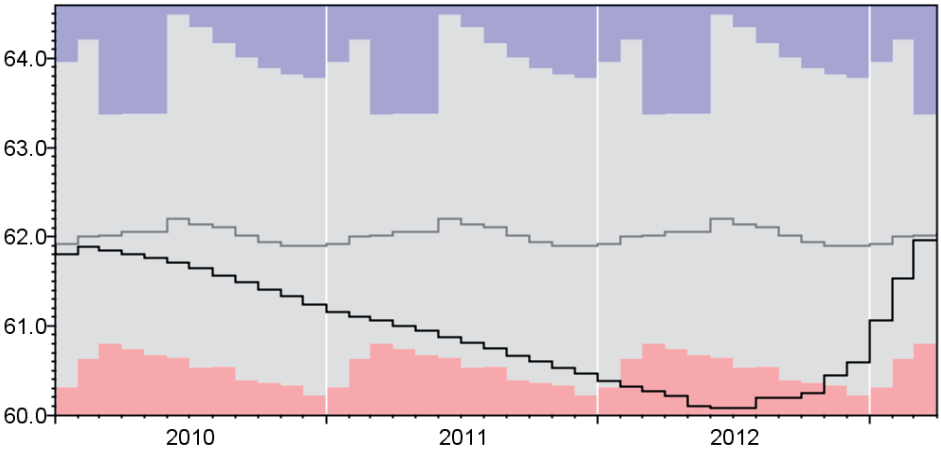


Fig 3 *Monthly mean groundwater levels for the Heathlanes borehole in the Permo-Triassic sandstones; pre-2012 monthly max. and min. levels are represented by the blue and pink envelopes, the grey trace is the long term monthly average.*

the unsaturated zone and, particularly, the high storage capacity of the sandstones, resulted in groundwater levels only returning to average in April this year.

Terry Marsh
Centre for Ecology & Hydrology
tm@ceh.ac.uk
24/4/13

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■ Membership enquiries: Tim Fuller, BHS Secretary, Institution of Civil Engineers, 1-7 Great George Street, London SW1P 3AA. Tel: 0207 665 2234 Email: bhs@ice.org.uk

■ Editor: Celia Kirby Tel: 01544 230053
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