Circulation

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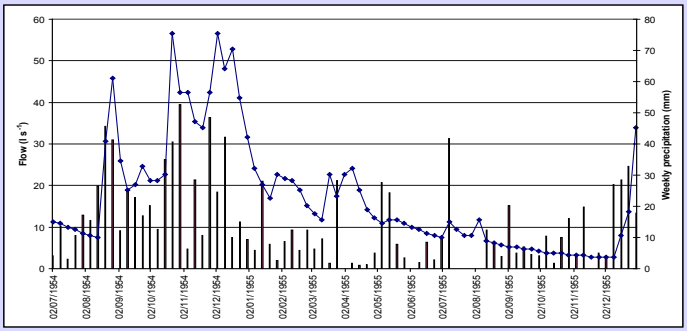
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Hydrological echoes from the archives

The University Archives of the University of Dundee recently had the opportunity to acquire an archive of municipal water supply records dating back to 1880 relating to the water supplies for the City of Edinburgh. This seemed a rare opportunity to capture for long-term preservation records of hydrological conditions pre-dating systematic hydrometric monitoring by several decades. It raises questions about the existence or loss of other comparable records in other parts of the UK, and their possible role in future studies.

The materials acquired comprise operating logs of reservoirs and springs used to supply Edinburgh and the surrounding area. Typically, log sheets show: water levels in reservoirs, rates of supply to demand centres, compensation flows, rainfall and sometimes weather observations, all at a daily time interval, with times of changes also noted. Spring flows are monitored only weekly, but benefit from measurements by volumetric methods and often seem to be fairly stable on a week-to-week basis. There are some daily records from evaporation pans, but no borehole records.



1955 drought flow, Black Springs, Pentland Hills

Almost 1000 years of bound ledgers have been acquired by the Archives, as a complete collection, along with many original papers and plans and photographs regarding the development of the various sources. These allow interpretation of the time series data in an appropriate context. The materials have been catalogued and now benefit from appropriate storage to allow long-term survival.

Given inclusion in the records of some notable periods of drought, e.g. the early 1930s, it is anticipated that the materials ought to be of some significant ongoing value. Frustratingly, industrial action and 'stopwatch broken' (for 2 years!) obliterated much of the potential value of the 1970s drought in these records. Nevertheless, several of the longer time series have now already been extracted into digital form, three student dissertations have been completed to date, a SEPA R&D report has examined the hydrological behaviour evident in some of the longer spring flow records, and Scottish Water and their contractors have taken an interest in some of the data in relation to the planning of future water resources. Potential has been identified for using one of the series to assess the effects of suburban development on the flow of springs at Comiston (first developed in the 17th C).

Data quality must be an issue when using records so long after they were collected and where considerable uncertainty may exist regarding the precise meaning of the recorded measurements. Nevertheless, the nature of the extended periods covered by these records, and the relatively dense coverage of the area in question do point to considerable potential value in the records.

Enquiries regarding similar archive materials for other parts of Scotland have drawn only blanks so far. Do you know of comparable municipal water authority records pre-dating the early development of the stream flow gauging network in other parts of the UK? If so, the chances are that a wider audience would be interested in what you know. I'd personally be glad of any pointers you would care to share. Perhaps you have your own comments or experiences in using sources of this sort. In either case, or for other hydrological reasons, please consider using the BHS-HYDROLOGY@JISCMAIL.AC.UK email list. It's available for just this kind of dialogue. Enquiries to me regarding access to the archives now in Dundee are also very welcome.

Andrew Black
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New journal

IWA has announced the launch of *Journal of Water and Climate* which publishes refereed research and practitioner papers on all aspects of water science, technology, management and innovation in response to climate change. For more details, see www.iwaponline.com/jwc

President's piece

I am writing most of this PP from India where I am working as part of the Hydrology Project, which is trying to improve the collection, processing and use of hydrological data in much of the country. I have been involved to some extent in this project since 1993, when I was part of a World Bank mission responsible for formulating and costing the project. Back in the mid-1990s hydrology in India was a very weak subject, taken half-seriously by the national government, but largely ignored by the vital State governments, where hydrology and hydrogeology were generally small parts of the State irrigation of rural water supply department. India has a federal government, where much of the legislative and financial power is vested in the states, and where states have control of the water resources within their boundaries.

Unfortunately most of the rivers flow across state boundaries, and water sharing is a major problem. Hence data collection was often poorly carried out, as was data processing in the office, and in some cases river flow data were selectively 'massaged'; the upstream state claiming the flow to a downstream state was 120 m^3s^{-1}, whilst the receiving state gauge measured only 80 m^3s^{-1} and in general a better quality (and honest) Central Water Commission (CWC) station would record about 100 m^3s^{-1}. In addition, states were reluctant to publish data or release it to outside agencies outside of their state and design and operation of schemes on trans-boundary rivers was consequently very difficult in the situation where data were not freely available.

Finally, as hydrological data collection was undertaken by what are essentially engineering departments, staff assigned to the work often have limited knowledge and training on the subject, but more importantly, such staff actively seek transfers to construction supervision activities where there may be certain 'financial side benefits' to supplement their meagre salaries that are not attainable through hydrological data collection.

During my first visits in the mid-1990s these and other problems demonstrated clearly that hydrology was in a poor state in India, and hence the World Bank effectively forced the national and state governments to sign up the ambitious and expensive Hydrology Project. Phase I of the project (HP-I) between 1998 and 2003 involved over $200 million investment, and the second phase (HP-II) which I am involved in, and which started only in 2008, will have a further $110 or so of investment. The question then is, has this massive investment of equipment, buildings, computers and training during Phase I actually achieved anything useful?

Well, I have only been out here for a short time so far, but I must admit that first impressions are very favourable. During HP-I between 25,000 and 30,000 hydrological staff received new training, ranging from field data collection through data processing, water quality measurements and lab work, use of computers and data processing to project management. Whereas groundwater level data were originally collected just twice a year (once in April or May immediately before the monsoon and a second reading in October or November just after the monsoon) many observation wells now have digital water level recorders and 6-hourly readings (admittedly probably excessive!) and data may be downloaded once a month directly to either a handheld PDA, or nowadays to a laptop.

However, it is not just the data observations that have improved; the data are now being quality controlled, published and really **used**. Yearbooks of data are now published and circulated to all relevant state and central government departments, and appropriate sub-sets of these data sets may readily be purchased by consultants, contractors and researchers (costs are fairly nominal and designed to help fund the data processing and publication tasks).

Before HP-I, any maps I was shown were poor quality hand drawn ones with little information about latitude or longitude (I'm not sure if there is an Indian national grid) and which could only be reproduced using old dyeline machines (which produced the blue reproductions familiar to older readers – the original 'blueprints'). Today you will be shown processed satellite images and colourful thematic maps produced using ArcGIS or similar, and if you ask for a copy, one is produced in a few moments by a well trained computer technician.

Such progress over just over 10 years is impressive.

For river flow measurements, rivers were gauged daily by either wading or from bridges or boats using locally manufactured cup type current meters. There were few cableways apart from a few operated by CWC, and rating curves were not really used; the daily current meter measurement was taken as the daily mean flow. As current metering is inherently not particularly accurate, flows tended to rise and fall by maybe 15-20% from day to day in the dry season, even though stage was constant. Many staff were making very poor current meter measurements as well; seeing the current meter set at 0.6 depth measured from the bottom up, rather than surface down was common, as were sites where the slope-area method was applied badly (two river level readings some 100-200 m apart are taken and these used to estimate water slope for use with the Manning's equation assuming the cross-section and bed roughness were constant). I saw several sites where both level gauges were dry, and hence the observed flow was recorded as zero, yet there was visible flow down the river; in one case I estimated this to be almost 10 m^3s^{-1}! The problems arose because sand and gravel is often mined from river beds for construction purposes, hence the assumption of a stable cross section at the gauging station was a nonsense, but with poorly trained staff nobody had recognised the problem; they had been trained to follow a measurement procedure, which they were doing religiously, yet the process was quite obviously fatally flawed!

Through the massive HP-I training programme, such errors have generally been corrected, and the field staff I've met are performing much more effectively with better equipment and better data processing and checking using computers being the new norm. Once again, there are very obvious signs of improvements brought about by the project, and we are even thinking of introducing some advanced ADVP (Acoustic Doppler Velocity Profilers) at some sites in Punjab where rivers are too wide for cableways and sediment loads are high.

Thus my overall impression is that this massive investment by the national and state governments in hydrology throughout India is making a real difference to the availability and quality of hydrological data (surface water, groundwater and now water quality – never measured before HP-I). These new data sets, supplemented by re-working and checking older manuscript historical records, is providing data sets which are enabling Indian hydrologists to undertake a range of applied studies such as regional flood and drought analyses, multi-purpose reservoir operation studies, studies of reservoir sedimentation. Finally, the water quality data will slowly help with prosecution of industrial polluters and hopefully to improve the quality of urban and rural water supplies; although national and state pollution control boards existed for many years, they had very limited data available to them, but HP-I and HP-II are once again making a difference. It is very gratifying to see significant progress being made in many areas of hydrology in India although, heaven knows, there is still a long way to go!

Talking of hydrological data collection and use of such data to solve real-world problems, reminds me that the Peter Wolf Young Hydrologists Symposium will be taking place at the University of Liverpool in mid-June and I look forward to hearing a number of stimulating talks at this symposium. I very much enjoyed last year's meeting in Edinburgh and was very encouraged by the enthusiasm and genuine ability demonstrated by all the young hydrologists I met there. Who knows, maybe some of you can come out to India or to another country where your knowledge, training and enthusiasm can help to make a difference to hydrology and water resource assessment and management.

Finally, I attended the joint ICE/CIWEM meeting on flooding issues in Wales in March, which was a very well organised programme including a presentation by the Welsh Assembly Government minister responsible for flooding issues. During this meeting, I was taken to task by John Mosedale over a previous PP where I'd talked about the institutional complications of flood management in England with the overlapping roles of the EA, Local Authorities and water utilities not always clear. John pointed out that things are different in Wales, with there being just a single EA region and one government agency (the WAG), and where local government is also organised differently to England. Sorry, John, I accept that my wrist has been severely slapped, but perhaps this parting thought harks back to the main theme of this quarter's PP – if managing hydrology in the UK is

still far from perfect, should we be surprised that hydrology in countries such as India still needs advice and support from enthusiastic UK hydrologists.

I ended my last PP by saying "don't worry about the credit crunch, the UK still needs hydrologists" and this point is even more important globally; UK hydrologists have a great deal to offer – provided someone can be persuaded to pay for your inputs. If you are a hydrologist, the developing world needs your inputs!

Frank Farquharson

A letter to the Editor

Dear Sir / Madam

I read the President's Piece in the 100th Edition of Circulation, February 2009, with interest, in particular the section regarding the forecasting of surface water flooding. This is a topic which has received considerable attention in the last 12 months; with the production of the Pitt Review on the Summer 2007 floods particular focus has been centred around what can be done to either alert or warn people of potential surface water flooding — a significant issue in both the summers of 2007 and 2008, but a problem in the past also.

Discussing research in this area, the President comments that "it may well be that meteorologists are not necessarily the best placed specialists to undertake such work without hydrological (and hydraulic) support". I would agree that meteorology alone cannot solve this problem and that direction and assistance from the hydrological community are vital to ensure that forecasts are tailored and structured such that they are effective to those who receive them. For this reason, the Met Office has worked with and continues to work with hydrologists and hydrometeorologists in developing its services.

The trial Extreme Rainfall Alert Service, established in partnership between the Met Office and the Environment Agency in July last year, was developed to inform of the risk of surface water flooding based on exceedance of rainfall depth-duration thresholds which were established by hydrologists. However, it is also true to say that the recent development in quantitative precipitation forecasting (QPF) within the Met Office (ref. Roberts *et al*., 2008) is particularly important for developing surface water flooding alerts. Because surface water flooding has so little lead time between the rainfall and the onset of flooding, forecast rainfall information is vital to allow mitigating actions to be taken.

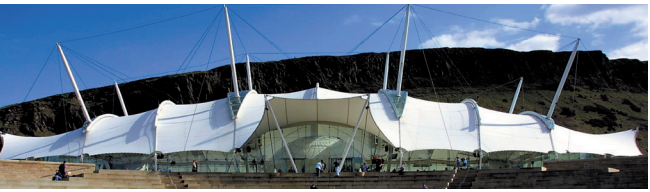
Therefore, I think the challenge for us all moving forward, and responding to Pitt's recommendations, is for meteorologists and hydrologists to work more closely together, for each to understand the challenges the other group faces and to work in a positive spirit of partnership.

Regards

Murray Dale

Recent developments in water resources North and South of the Border

SHG/BHS meeting, Edinburgh 29th October 2008



Our Dynamic Earth, located in the heart of Edinburgh, welcomes visitors by inviting them on "the journey of their lifetime." They will have the "Mother Earth" of all adventures as they travel back to explore our planet's past, embrace our planet's present and predict our planet's future. Visitors are told that they will "hold our futures in their hands" as their minds are opened to the realities of climate change. So, in this *International Year of the Planet*, this was the ideal venue for hydrologists from north and south of the border to gather together to discuss recent developments in water resources.

The purpose of the meeting was to reflect on recent developments in water resources, largely driven by the Water Framework Directive (WFD) and the Birds and Habitat Directives (B&HD), by drawing together speakers from both sides of the border to compare and contrast the recent developments in Scotland with the more established approach adopted in England and Wales. With the imminent publication of the first draft River Basin Management Plan (RBMP) this was an opportune time to reflect on work being progressed by the respective agencies and water companies.

Tim Jolley (SHG Honorary Chair) welcomed the 70 attendees and introduced the first speaker, **Hilary Smithers** (SEPA).

Hilary gave the first part of "*Delivering WFD in practice*" (joint with Robert Stewart and Caroline Jones, Scottish Water) with a regulatory perspective on public water supply. She explained the screening process used by SEPA to focus attention on 78 water resource zones (WRZ) and the process developed together with Scottish Water to study the 78 WRZ to identify best environmental options for meeting the requirements of the WFD and B&HD at least cost (Fig. 1). Specific challenges, such as the development of new water resource standards, improving the hydrology in data-sparse areas, estimating demand growth and ensuring the efficient use of water were discussed in detail. Hilary emphasised the value of collaborative working between the regulators (both SEPA and the economic regulator, WICS) and Scottish Water and the need for pragmatism in overcoming issues and challenges when applying new standards and implementing new processes. Many challenges remain for SEPA, including linking hydrology and biology to further develop the water resource standards, gaining wider acceptance of an approach that delivers incremental



Figure 1. The agreed Q & SIIIa process

improvements and refining elements such as SEPA's application of the WFD exemption tests and coupling the assessment with the licensing process.

Robert Stewart then talked about Scottish Water experience of delivering WFD in practice. Robert explained the background to the Quality and Standards III capital investment program and the associated water resource drivers. Drivers included WFD impacts on abstraction (WR1), Drinking Water Protected Areas (WR3), abandoned structures (WR4), measurement and monitoring (WR5) and B&HD (DW7). In total, £45M had been allocated to capital investment April 2006 to March 2010. Robert discussed the challenges from a Scottish Water perspective (Fig. 2) including balancing compliance with the water resource standards against the resulting environmental benefit. When faced with standards that are hydrology based with no ecological measures and no established detailed rules for defining what is a proportionate cost, both SEPA and Scottish Water had to work together to develop a value management process that allowed stakeholders to deal with issues in a pragmatic and consistent way. In addition, leakage monitoring and flow gauging were identified by Robert as key activities that needed to be further developed to reduce uncertainties.

The impact of the WFD on abstractions (WR1) was then presented by **Caroline Jones** who explained how the 78 WRZ, through strategic studies, had been classified as one of five forms of solution. No further work would be required at 40 WRZ, revised abstraction licences would be required at 16 WRZ, strategic options were to be implemented at 7 WRZ, local schemes were to be implemented at 10 WRZ and further studies were required at 6 WRZ. Caroline then presented three case studies: North

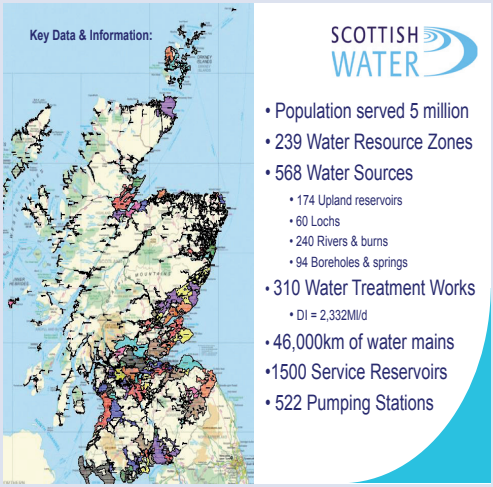


Figure 2. Water resources in Scotland

Coast Regional Scheme WRZ, the Talla and Fruid Reservoirs, and Penwhirn Reservoir. Each example highlighted a specific issue. For the North Coast Regional Scheme Scottish Water had to modify the operation of a hydro power scheme to comply with the water resource standards. The Talla and Fruid Reservoirs was an example of a reservoir cascade where modification of the existing compensation flow regime was sufficient to meet the new standard. Finally, Penwhirn Reservoir was an example of where flow gauging allowed Scottish Water to increase confidence in the hydrology and demonstrate the existing source was compliant with the new standards.

Robert ended the joint presentation by agreeing with Hilary's concluding message. This was the first time that WFD rules had been applied in Scotland and, as such, the collaboration of the regulator and operator was essential. While challenges remain, the programme has been an important vehicle for developing and testing our understanding of the new regulations and the developments in hydrology that are required to support them.

Kath Tanner (Environment Agency) then took us south of the border to give an overview of the on-going Restoring Sustainable Abstractions programme. The main drivers of this programme are the Habitats Directive Review of Consents, CRoW Act (SSSI), Biodiversity Action plans, local concerns and the CAMS (Catchment Abstraction Management Strategies) process. In future, this programme will include WFD measures.

Kath started with a brief chronology of recent water resource developments addressing abstraction

pressures, starting with the identification in 1992 by the National Rivers Authority (NRA) of the top 40 low flow rivers and ending in 1999 with the "Taking Water Responsibly" initiative that led to the setting up of the Catchment Abstraction Management Strategies (CAMS). Kath proceeded to focus on the Habitat Review of the Consenting Process that was triggered by the Habitats Directive and the establishment of the Environment Agency as the Competent Authority. Kath described the four stage process developed by the Environment Agency to assess each licence: the first two stages question the relevance and the significance of the abstractions and act as a screening test to find those 'permissions' that need to be investigated further; the third stage 'Appropriate Assessment' seeks to conclude whether or not the abstraction is affecting a European site. Unless after this stage it can be concluded that there is no effect, further action is necessary under stage 4 of the process. Kath explained how knock-on effects to other sites were accounted for and addressed any over-riding public interest. For example, if the source was used for public water supply then this was interpreted as an over-riding public interest. In summary, the process led to 51 voluntary applications for licence changes, 51 voluntary applications relating to public water supply (and so funded by the Price Review process), 52 licence changes proposed by the Environment Agency (requiring compensation payments). Kath observed that £450M had been allocated to the implementation of the B&HD in England and Wales but noted that unlike for the WFD there was no benefit/cost test for the B&HD.

Kath went on to report on recent developments with respect to the WFD. The Environment Agency will be building in some UKTAG standards into their CAMS approach to assess the environmental objectives for a specific source. The Agency has experienced some significant issues in meeting the UKTAG standards because, unlike in Scotland, there was a well established system for assessing standards in place. It has been forecasted by the Agency that the cost of implementing the UKTAG standard will therefore be substantial.

There followed a general question and answer session on the morning's talks. Hilary was asked whether a revised Characterisation was due to be published. Hilary confirmed that SEPA are updating the Characterisation. In response to a question on leakage Robert explained the approach taken by Scottish Water to allocating leakage to different investment drivers. For rivers, all drivers benefit from reduced leakage while for reservoir sources conflicts can arise between resolving a supply-demand deficit and, say, meeting a WFD requirement. Hilary added that SEPA understand the issues faced by Scottish Water and accepted that a number of measures were being taken to reduce leakage; however, they wanted to see the environment benefit from reduced leakage. A further question related to whether SEPA would be considering flood risk when licensing water resources, to which Hilary replied that SEPA would indeed consider a range of issues when determining a licence.

The afternoon session was chaired by **Nigel Goodie** (SEPA), who introduced first his colleague **Michael Wann** (SEPA). For this post lunch slot, Michael did not disappoint the audience, with an entertaining presentation about regulating hydropower abstraction. Hydropower is one of Scotland's largest sources of renewable energy, therefore contributing to a reduction of CO_2 emission and it is a key challenge for SEPA to balance the development of hydropower and the protection of the water environment. Under the Controlled Activity Regulations (CAR) process introduced on 1 April 2006 to implement by the WFD, authorisations are required for new and existing abstraction, impoundment and engineering. CAR also introduced a charging scheme. To date, SEPA has received 27 applications for new hydropower schemes and only one licence has been refused. Applications range from small 9kW schemes to the large Glendoe scheme currently under construction in the Highlands. Their potential impacts include some short term ones during construction: sediment runoff and sediment mobilisation, contamination from oil, engineering works such as diversion and pumping; and some long term ones: reduced low flows and mid range flows (impacting on biodiversity), impact on fish and fisheries (migration and spawning), loss of wetted margins, sedimentation problems, impact on third party users. New environmental standards were introduced by the Scotland River Basin District Directions 2007 to ensure that the water environment is protected. However, the vast majority

of applications for hydro-schemes will breach the standards and some will also threaten the ecological status of the water body, therefore requiring SEPA to report it to Europe in the River Basin Plan. To authorise the schemes, SEPA needs to strike a balance between the socio-economic benefits and environmental impacts and apply derogation (exemption) tests as set out in Article 4(7) of the WFD. Some regulatory methods have been developed to provide guidance to SEPA staff. Among the information required, SEPA needs detailed hydrological data supporting the flow duration curve (FDC): desk-based methods may be acceptable for small schemes but direct measurements are usually required to develop long term FDC curves. A 'hydro guidance' document should be available to applicants in summer 2009. Michael then detailed what mitigation measures can be implemented. These include hands-off flows, compensation flows, flow variations, freshets, sediment management, fish screen, fish pass, taking into account third party usage (e.g. canoeists). Michael closed by outlining issues with the review of existing schemes (retrofitting mitigation measures can be difficult and expensive) and the assessment of the cumulative impact of schemes. These are some of the challenges for the future.

Next, **Jackie Galley** of SEPA provided an update on the development of the Solway-Tweed River Basin Management Plan, and discussed the particular challenges when doing this work for a catchment with a unique cross-border setting. With SEPA and the EA charged with working together to achieve the production of a single plan, those involved have dealt with the differing legislative backgrounds and working procedures in place north and south of the border and have put in place specific joint working procedures to achieve their shared aim,

Ian Preston (Environment Agency) provided a view from south of the Border on water resources regulation in the cross border catchment of the Tweed, and in particular the River Till, the main English tributary of the Tweed. He looked at the water resources issues, the current legislative constraints and how they are evolving.

The EA manages water resources through CAMS which provide a mechanism for providing and reviewing time limited abstraction licences. The process includes an assessment of resources (determining the minimum environmental flow) and water availability (what would happen if all abstraction licenses were fully utilised) and determines the licensing strategy. However, previous legislation (Water Act England and Wales 1963) had exempted the Till catchment from regulatory control by the EA and therefore it was difficult to protect the catchment from potential over-abstraction. This despite the sensitivity of the catchment (an SSSI on account of salmon, sea trout and lampreys; the Till is also part of the Tweed SAC) and potential over-abstraction due to spray irrigation for agriculture (potatoes). Through working with English Nature and abstractors, the EA managed to produce a 'best endeavours' CAMS. It resulted in English Nature issuing new consents requiring a phased reduction of abstraction. New legislation removing the exempt status of the Till area is expected to be in place next year and the Till CAMS will need to be updated by 2011. For this, the EA will work in close liaison with SEPA to ensure adequate flow information is available to determine licences. Ian then moved his presentation to issues in relation to the Solway-Tweed river basin management plan, where the EA and SEPA are working together. In particular, Ian highlighted the differences in setting environmental standards. However co-operation is essential to ensure a truly catchment based approach to environmental regulation.

Then, in the first of two talks about assessing abstraction impacts, **Nick Green** of Mott MacDonald presented a study of the River Tweed and tributaries. Using data from a variety of sources, including historical and current field surveys, hydrological modelling and hydrometric measurements, the study looked for evidence of watercourse changes that may have had impacts on otter, Atlantic salmon and lamprey populations within the River Tweed SAC and which can be linked to abstraction (see Fig. 3 overleaf).

The final talk of the day was from **Susan Makirdy** (Environment Agency) who presented the second talk about assessing abstraction impacts and focusing on the *Review Of Abstraction Licences in Cumbrian Special Areas Of Conservation*. Susan discussed three case studies for which the Habitats Directive Review of Consents process was carried out: she focused on stages 3 and 4 of the process as stages 1 and 2 are a screening

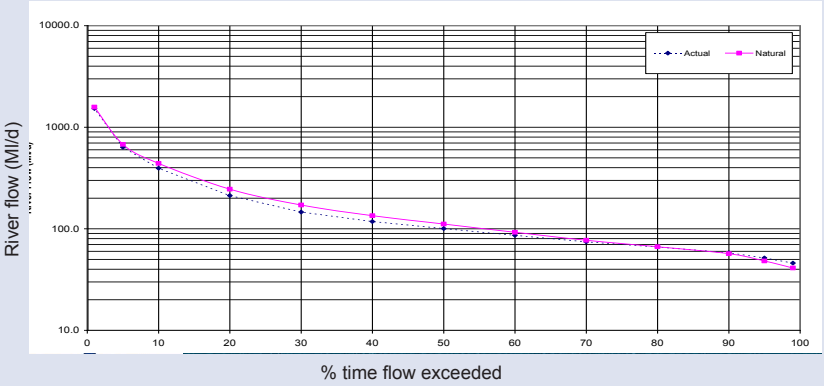


Figure 3. Natural (pink) and impacted (blue) flows for the Whittader Water (summer)

exercise only.

Case study 1 was a large abstraction for public consumption from the Ennerdale Lake near the River Ehen SAC. The River Ehen SAC contains populations of Pearl Mussels and Atlantic Salmon. It was necessary to investigate the effects of abstraction on these communities. This was relatively straightforward for the salmon as they are well known and parameters such as low flows, migration flows, geomorphology, flow variability and sediment supply were investigated using surveys, rainfall, lake level data and modelling (to estimate naturalised flows). Pearl mussels are less known and an expert in Ireland was used to survey the population in addition to the use of research from another river. It was concluded that compensation flow was a little too low and there was a problem with the fish pass. In addition, sediment from Ben Gill was not reaching the lake. As a result the review went to stage 4 and licences were changed (reduced) and a staged compensation flow introduced.

Case study 2 was a large abstraction for public consumption from Wast Water relevant to the Wast Water SAC. Two licences apply to the lake: one for use at Sellafield and one for compensation flows to the River Irt. On investigating the lake area and lake levels it was shown that neither had a large impact on the Arctic Charr and macrophyte communities. Long datasets were available and the Mospa model was used to predict lake levels. There was no need for a stage 4.

Case study 3 was a small non-consumptive abstraction for private hydroelectric supply from Lodore Falls near Derwent Water and the Borrowdale Woodlands SAC. Many rare bryophytes which are very sensitive to moisture conditions are present in the area of this steep and flashy stream. However, different species have different preferences. A survey was carried out that identified 14 species that were not refound from a previous survey but 32 additional species were identified. This meant that no stage 4 was necessary.

Questions and answers for the afternoon sessions included a question from **Charles Malcom** of SEPA about the dampening effect of lakes and reservoirs on flows downstream and how to model natural flows for existing schemes. Hilary Smithers asked if any actions were taken over the sediment problem at Benn Gill. Susan replied positively and said that the Benn Gill licence will be revoked and the natural course of the river will be put back. However, this may cause problems for the fish pass with additional sediment.

This was a good way to conclude the day, highlighting the many challenges faced by regulators.

Tim Jolley (Mott MacDonald)
Fay Campbell (JBA)
Anita Assadulah and Pascal Lardet (Halcrow)

AGU Fall Meeting

San Francisco, USA,

15-19 December 2008

These AGU meetings are always huge events so we are grateful to the group from Aberdeen University for this useful summary of the sessions of interest to UK hydrologists.

Deciphering the role of surface and subsurface processes on solute dynamics at the catchment scale
This session was opened by **J. Harvey's** (USGS) talk on scaling hyporheic flow and biogeochemical reactions across a wide range of flow and sediment conditions in aquatic systems. **W. Wollheim** (University of New Hampshire, US) discussed the influence of various aquatic ecosystem types on biogeochemical fluxes at river network scales. **A. Woerman** (The Royal Institute of Technology, Sweden) covered the interesting issue of topographical scaling of surface water-groundwater interaction in the hyporheic zone. **C. Soulsby** (University of Aberdeen, Scotland) presented multi-scale dynamics of surface and subsurface processes and effects on the hydrochemistry and hydroecology of a montane salmon spawning stream. The session closed by **S. Wondzell's (**Olympia Forestry Sciences Lab, US) presentation on the changing role of hyporheic exchange flows across a stream network.

Catchment processes and heterogeneity at multiple scales: benchmarking observations, conceptualization and prediction
Process conceptualization is fundamentally important to both process understanding and prediction in catchment hydrology. Given the importance of heterogeneity at all scales, it requires the development of diagnostic classification tools that integrate measurement and consider factors such as topography, topology and typology to develop indices of similarity for prediction in ungauged or sparsely gauged basins. This session was organized as part of the scientific activities of the Theme 2 *Conceptualization of process heterogeneity* initiative in Prediction in Ungauged Basins (PUB/IAHS). **Peter Troch** (University of Arizona) gave an invited talk on linking flow processes to landscape characteristics through isotope hydrology in semi-arid catchments. The following talks all presented experimental field studies which included multi-scale catchment monitoring attempting to encapsulate spatial scale issues: **Yuko Asano** (University of Tokio): Are headwaters just the sum of hillslopes? Evidence from geochemical and isotopic observation; **Adrian Harpold** (Cornell University): Effects of groundwater springs on spatial sources of baseflow in the Catskill Mountains, New York State, USA; **Russell Smith** (UBC Vancouver): Spatio-temporal variability in midwinter snowmelt generated by ground heat flux: implications for catchment hydrology; **Ryan Lucas** (University of California): Investigating Meadow Hydrology and Hyporheic Exchange. **Sean Carey** (Univ. Of Ottawa) then presented a novel approach of energy-based runoff generation theory for tundra landscapes.

The second block of this session covered several contributions on geographically and climatically transferable approaches of process conceptualization. It started of with **Jim Kirchner** (Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf, Switzerland) discussing catchments as simple dynamical systems, at different scales and in different climatic regimes; followed by **Jan Boll** (University of Idaho, Moscow) on regional classification for the identification of dominant hydrologic flow paths and critical management zones; **Thomas Grabs** (University of Stockholm, Sweden) on stream water quality in the boreal krycklan catchment, Northern Sweden and **James Craig** (University of Waterloo, Canada) on upscaling threshold nonlinearities in distributed surface water models. **Doerthe Tetzlaff** (University of Aberdeen) presented results from an international initiative on conceptualizing landscape controls on catchment transit times in different geomorphic provinces. **Chris Spence** (Environment Canada, Saskatoon) presented results on storage dynamics of a subarctic Canadian shield catchment. The third and last oral

block of this session started with the second invited talk given by **Jim Buttle** (Trent University, Peterborough, Canada) who discussed emerging hydrological processes with increasing spatial scale and his T3 template using examples from forested precambrian shield landscapes. Following on, **Axel Anderson** (Alberta Sustainable Resource development, Calgary) talked about watertable response characteristics in hillslopes dominated by preferential flow; **Chris Graham** (Oregon State University, Corvallis) about the physical meaning of hillslope thresholds; **Sarah Godsey** (University of California, Berkeley) about the accuracy of time-domain and frequency-domain methods used to characterize catchment transit time distributions and finally, **Alberto Montanari** (University of Bologna, Italy) on the links between drainage density and river flow regime.

Critical role of long-term watershed and ecosystem experimental networks in advancing science
The session started with a talk by **Susan Moran** (USDA) who identified 81 experimental watersheds with more than 20 years of eco-hydrological data. Several presentations focused on the use of long-term datasets on paired watershed studies: while **Leon Bren** (University of Melbourne) highlighted the need for ongoing operation of already instrumented watersheds, **C. Rhett Jackson** (University of Georgia) summarized problems known about and information to be extracted from long-term paired watershed studies. Another aspect of the utility of long-term data sets was shown by **Georg Jost** (University of British Columbia) who used a fully distributed model (DHSVM) to model the effect of land-use change in a snow-dominated watershed. **Dan Hogan** (BC Ministry of Forestry) presented impressive results of 38 years channel surveys at Carnation Creek and **Markus Hrachowitz** (University of Aberdeen) demonstrated how a 17-year tracer data set from 21 catchments in seven regions of Scotland helps in constraining and identifying first-order controls on mean transit times. A very intriguing and ambitious project was presented by **Theresa Blume** (University of Potsdam): the Experimental Hydrology Wiki which aims at collecting and making accessible existing knowledge about experimental hydrology.

Understanding hydrologic modelling error: pathways towards improved model diagnosis, correction and practical Application II.
Kathryn van Werkhoven (Pennsylvania State University) showed results that indicate a strong control of the spatiotemporal extent of precipitation on the information content of streamflow. Some other projects focused on various limitations of the Nash-Sutcliffe Efficiency: **Harald Kling** (University of Arizona) highlighted the varying importance of different components of NSE, like the bias and the correlation, in calibration and validation periods. On the other hand, **Barry Croke** (Australian National University) suggested an approach to incorporate measurement errors in the NSE. A method for robust model parameter estimation based on the assumption of time variant parameter sets, which allows a better representation of reality, was introduced by **Shailash Singh** (University of Stuttgart). **Jeff Baggett** (University of Wisconsin) presented several combined efficiency enhancements for evolution strategies which allow automatic calibration of complex models with a reduced number of model runs.

Recent development of statistical tools for hydrological application I
One of the highlights here was a sophisticated application of the wavelet method to identify causality and scale dependence across several rainfall time scales by **Annalisa Molini** (Duke University). **Andras Bardossy** (University of Stuttgart) presented an investigation of multivariate analysis of the spatial structure of precipitation, while **T. Kim** (Korea Institute of Geoscience) introduced Empirical Mode Decomposition, a method to decompose time series into stationary and non-stationary components. The uncertainty in the structure of models was analysed by **Nataliya Bulygina** (Imperial College), using the difference between prior and posterior structures within a Bayesian framework.

Impacts of climate variability and change on water quality
Using long term data series, **Bridget Scanlon** (Univ. Texas), **Gunnar Lischeid** (Univ. Bayreuth) and **Chris Soulsby** (Univ. Aberdeen) looked at the implications of climate change on the seasonal and inter-annual

patterns of water chemistry. **Victoria Keener** (Univ. Florida) stressed how variability in the ENSO cycle could be used to predict nutrient loss in the SE United States. Simulated stream temperature data were presented by **Omar Abdul-Aziz** (Univ. Washington) to emphasize the potential geographic range and quality changes in salmon habitat within the freshwater domain in the Pacific Norwest. **Brian McGlynn** (Montana State Univ.) looked at landscape controls on stream flow generation and land atmosphere fluxes.

Landslides, debris flows and avalanches
The application of computer models as tools for providing insights into mass movement was the main theme of this session. A coupled solid deformation/fluid flow model for capturing shear localization and landslide initiation was presented by **Joshua White** (Stanford Univ.) while **Eileen Weppner** (Pacific Watershed Asso.) evaluated the performance of three spatially distributed slope stability models implemented using a LiDAR digital elevation model (DEM). **Taro Uchida** (Public Works Res. Inst.) discussed soil thickness as a primary control on shallow landslides while **David Milledge** (Durham Univ.) presented results which highlighted that lateral reinforcement becomes important for landslide lengths and widths <20m.

Understanding hydrologic modelling error: pathways toward improved model diagnosis, correction and practical application
This session began with a look at the impacts of precipitation uncertainty on main stem discharge calculations (**Hester Biemans**, Netherlands Environment Assessment Agency). **Martyn Clark** (National Institute for Water and Atmospheric Research, New Zealand) then described the use of FUSE (Framework for Understanding Structural Errors) to understand reasons for model weaknesses. **Sankar Arumugam** (North Carolina State Univ.) compared the performance of multimodel combinations against the use of single models for generating streamflow predictions. **Gerrit Schoups** (TU Delft) used various model structures in an attempt to identify an appropriate level of model complexity to accurately translate rainfall into runoff.

Spatiotemporal patterns of hydrological processes in forest ecosystems
This opening Hydrology session, proved to be of interest for biogeoscientists concerned with the role of forests on hydrology. The programme included 7 oral presentations and 21 posters. The contributions covered very different geographical regions discussing how forest ecosystems influence the spatial and temporal distribution of hydrological processes. Successful monitoring and modelling efforts at different scales were presented to tackle this variability.

Isotope tracers of biosphere-atmosphere interactions: advances in measurements, theory and analysis
This biogeosciences session contained 14 talks and 35 posters and presented a balanced mix of topics. The oral part concentrated on the understanding, conceptualisation and modelling of biogeophysical processes using different isotopic approaches. The audience was introduced to a wide range of isotopic methods for investigating hydrologic, climatic, geologic and biologic interactions. The latest technology in isotope analysis was presented in the poster session and caught special attention among many hydrologists due to the usefulness for hydrological questions.

Scale, scaling and non-linear variability in space-time precipitation: data, measurements, models and theories
This non-linear Geophysics session contained presentations and posters (8 and 10) to characterize the spatio-temporal variability of precipitation through statistical approaches, such as fractal analysis, and through measurements using the most recent radar and satellite remote sensing techniques. Special attention received the spatial and temporal non-linearity of extreme precipitation events.

Christian Birkel, Markus Hrachowitz, Mark Speed and Doerthe Tetzlaff
University of Aberdeen)

Hydromorphology and the Water Framework Directive

BHS National Meeting
University of Liverpool
8th January 2009

This meeting, co-organised by BHS and the British Society for Geomorphology, comprised a series of interesting and stimulating presentations. The successful implementation of the Water Framework Directive in the United Kingdom requires mutual understanding and collaboration between hydrologists, geomorphologists, ecologists and biologists, and this was reflected in the varied and inclusive programme of speakers.

The meeting started with an introduction by **Edward Maltby** of SWIMMER (Sustainable Water, Integrated Management & Ecosystem Research) at the University Liverpool, followed by **Lucy Bolton** from the Environment Agency who presented the latest developments regarding River Basin Management Plans. Some significant statistics set the context for the rest of the day, and illustrated the task facing the EA and others working in the field. For example, 60% of the length of rivers in England and Wales are at risk of failing the required 'good ecological status' due to hydromorphology, while only 17 water bodies studied showed high hydromorphologic status. Another significant insight was that in terms of the WFD, hydromorphology only supports biological quality: i.e. should biological quality be sufficient, there would be no need to improve the hydromophologic quality.

Andy Large examined the role of hydromorphology and applied fluvial geomorphology in river basin management and highlighted the lack of a working definition and reference conditions for hydromorphology as a significant issue. He also addressed the need to accept that dynamism and change are essential parts of fluvial systems, and that morphology and ecological status would vary naturally with scale and on a reach basis, with alternating sensitive and resistant reaches showing ecological variability. **John Rowan** then shifted the emphasis to lake hydromorphology and raised many interesting points regarding the tools available for characterising, classifying and managing lake hydromorphology, specifically the Lake Habitat Survey and the Lake Morphological Impact Assessment System (MImAS), and highlighted hydrological regime as one of the most important controls on ecological quality.

Roy Richards from the Scottish Environmental Protection Agency then concentrated on the work being done in Scotland to implement the WFD. One important point made which put the WFD in context was that although a large proportion of the Scottish economy depends on the quality of the environment (e.g. salmon fishing, whisky, agriculture and tourism), a large number of Scottish rivers had been adversely affected by anthropogenic activity, leading to habitat loss and the disturbance of geomorphic

Have you seen.....

David MacKay's ***Sustainable Energy: Without the Hot Air?*** This is a review of our use of fossil fuels and just what is required to change this. No emotive journalism here, just a great example of how to put across a difficult topic in a beautifully clear way.

My plug for this book is an unashamed abuse of editorial perogative to recommend that you download it free from **www.withouthotair.com**. Like James Dent's excellent piece recently, it's always good to read some sensible prose on this topic.

Ed.

processes. Implementation of the WFD in Scotland had benefited from governmental direction on the use of MImAS, but had generally faced the same problems as in the rest of the UK such as the lack of tools and funding to enable managers to use geomorphology to assist good ecological status, and the lack of understanding of the links between physical and biological processes.

Michael Dunbar from CEH Wallingford discussed the interactions between river flow, habitat and macro-invertebrates in relation to the Water Framework Directive. The results of the research into different land-uses on habitat and biota were discussed using a variety of hydromorphological classification tools. The results illustrated seasonal flooding as having different impacts on biota, with considerable potential for future inclusion in modelling software.

Malcolm Newson, representing the Tyne Rivers Trust, then introduced a new and important element to the discussions - that of the general public who use and enjoy the environments that the WFD is designed to protect. The role of the trust was outlined; this includes conserving, protecting and improving the Tyne, and to educate the whole community about river corridors and catchments, and the flora, fauna, economic, social and management activity within them, many of which directly affect them as landowners and shareholders. One of the main points to note was again the need to expect hydromorphological instability, and to realise that returning a river or environment to 'nature' can often bring about greater risk.

The organisers, **Janet Hooke** and **Neil Macdonald,** then summarised the proceedings and chaired a discussion session. This was an excellent way of ensuring that the spirit of cooperation obvious in the variety of the speakers' backgrounds was put into practice to some extent. Many concerns were raised regarding the implementation of the requirements of the WFD and public perception of regulatory bodies when strategies are finally implemented. Communication of the aims of the WFD and of the strategies employed to meet them was a concern to many, as was a clear realisation of the need for greater cooperation between the organisations represented at the meeting. The precise mechanism for ensuring that cooperation was not as clear. To summarize, this meeting was an excellent and timely opportunity for people working - often independently - on similar and overlapping research themes to congregate and discuss the future of this very challenging directive. It was excellently organised, and will hopefully lead to more collaborative discussion and sharing of ideas.

Hywel Griffiths
Centre for Catchment to Coast
Aberystwyth University

New Flood Forecasting Centre

The EA's new Flood Forecasting Centre went live on the 1st April. The Centre is a partnership between the Environment Agency and the Met Office, combining meteorology and hydrology expertise into one team, in one national centre, to forecast for river, tidal and coastal flooding as well as extreme rainfall which may lead to surface water flooding.

The Service is for emergency responders (Category 1 and 2) only, aiming to deliver more targeted and consistent information with extended lead times so that emergency services, utility companies and local authorities can be better prepared to act.

The new £10.4 million centre (£5 million provided by Defra) is operational 24 hours a day, 365 days a year, employing a team of 26, including hydrologists, weather forecasters and support staff.

More information is available from: http://www.environment-agency.gov.uk/105596.aspx

Water, environment, energy and society

International Conference*
New Delhi
12-16 January 2009

With 234 papers covering 26 themes, 250 delegates representing more than 25 countries covering five continents and parallel sessions, this report can give only a selection of work presented and paper topics are highlighted instead of emphasising author names as is usual in BHS meeting reports.

The Plenary session was opened by Andras Szollosi-Nagy who described **Unesco's role in water, environment, energy and society**. He stressed the scale of the problem of providing enough safe drinking water for a rapidly growing population and the need for better planning. This was followed Takeuchi Kuniyoshi who talked about **flood disaster preparedness**. The difficulties included timely flood warnings and the need for better observational data on which to base the warning. Janus Starzyk gave a thought provoking talk on **Artificial intelligence and machine learning with applications in hydrology**. The essence was the reduction of pain through a goal creation system as compared with reinforced learning. Hence the avoidance of flood damage is really an avoidance of pain and should be looked at afresh in the light of embodied intelligence. (This could be an advance on the 'perceived peace' of Smith & Tobin, *Human adjustment to the flood hazard*, 1979).

A review of Indian rainfall was presented by Rakhecha & Singh. The variability of annual average state rainfall is from 55 cm in Haryana to 300 cm in Kerala. About 70% of this falls in the SW monsoon period. The highest one-day falls range from in excess of 50 cm along coastal areas of peninsula India to less than 20 cm in the north and west. Extreme rainfall of 100-year return period ranges from 50–15 cm in Kashmir. One-day PMP over India varies from 160 cm in the Western Ghats to less than 60 cm in Kashmir.

Making forecasts of extreme rainfall and managing their consequences for flood forecasting was described by Chris Collier. The error of radar based rainfall in the Dee Weather Radar Project can be about 10–20% for uniform rainfall but 40% or higher for more isolated showers. Nowcasting is done by the UKMO Nimrod system, later replaced by the GANDOLF system. However, forecasting of the Boscastle storm of 16/8/2004 was poor although the model at a resolution of 1 km gave better results. Considerable uncertainty exists in results and their use by the public.

The influence of the land surface on hydrometeorology and ecology: new advances from modelling and satellite remote sensing was presented by Hong *et. al*. Their results show good correlations between NDVI and surface temperature. These were used in modelling components of the heat balance. The results were typically R^2 = 0.8 for surface temperature, 0.75 for sensible heat flux, 0.72 for ground heat flux and 0.77 for latent heat flux for a 154-day period in three areas in USA.

Prediction of rainfall in West Bengal for the next two years was described by Choudhury & Chakrabrty. They used least squares technique and ANN. The results show a typical error of less than 1% e.g. 304 mm instead of 305 mm. Estimates for the years 2006 and 2007 were given as 322 mm and 323 mm but no comparison was made with measurements.

Evaporation in hydrological modelling was presented by Xu & Singh which described the well known methods of estimating evaporation. Evaporation pans were described but there was no mention of lysimeters.

Assessment of evaporation

*This conference was India's contribution to the UNESCO-IHP V11 (2008–2013) programme.

estimation methods in a semi arid region was described by Khodke & Gunbdekar for Maharashtra (India) for seven methods. The PM method was taken as the standard for potential evaporation. The results showed that FAO-24 followed by Penman (1963) gave R^2 of 0.96 and 0.95, down to 0.71 for the Priestly-Taylor method. The open pan estimate (design not described) gave the lowest deviation from PM method. No measurements of actual evaporation were used as a standard.

The development of a flood risk model for Romania was reported by Murthy, Jadhav & Chendes. They used discharge data from the UNESCO-IAHS catalogue of large floods and Romanian Waters Dept. to produce inundation maps for the river Danube. This will help catastrophe insurance schemes for the World Bank hazard mitigation project.

Impacts of urbanisation on streamflow was reported by Rudra, Dickenson & Ahmed on the Credit River down to Lake Ontario, with gauging stations Cataract (205 km^2), Erindale (795 km^2) and Orangeville (62 km^2). The extreme volatility index increased for Cataract (0.44 to 0.57) and Orangeville (0.45 to 0.52), while for Erindale it decreased (0.48 to 0.40). Over the period 1960–2003 the rainfall intensities declined for all durations and return periods for spring and fall between the years 1960–85 and 1986–2003. For summer there was a increase of about 15% for 12 hr–10 yr rainfall.

The role of snow and glacier melt runoff modelling in hydropower projects in the Himalayan region was the topic described by Singh, Polglase & Wilson. There is 29% contribution on the Ganga river, 49% on the Chenab; 60% on the Satluj; and 35% on the Beas river basin. Snow and ice is a natural frozen reservoir. Daytime and nightime discharges are similar during the summer months for the Dokriani and Gangotri glaciers. Peak power demand in India is in the morning 06–0900 hrs and evening 18–2100 hrs. Hence prediction of meltwater is important. A conceptual snow melt model using day degrees and rainfall will help to operate the hydropower scheme better under meltwater conditions.

Development versus sustainable development of groundwater resources in Indian context was described by Rai. He pointed out that unrestricted pumping of groundwater has led to failure of well and groundwater pollution. Water logging and soil salinity has also taken place. Sustainable groundwater development includes ground water recharging, which also includes subsurface dams. Fresh groundwater skimming of a 0.5–3 m deep freshwater lens which rests on seawater off the coast of Andhra Pradesh has been achieved; also cleaning recycled water using physical, chemical and biological methods.

History and perspectives of hydrological catchment modelling was presented by Todini. He began from the rational method (1850) through to the linear UH model up to 1960. Then came variable contributing models made up of components of the hydrological cycle. They included parameter optimisation whose values had little physical meaning. Later came PDM models but with parameters estimated from the data and thus not very physically meaningful. The TOPMODEL used a topographic index to give more physical meaning to soil water movement, but the meaning of the parameters was only true for very small catchments. Physically meaningful models and data driven models dominate the present scene.

Impending water crises: desertification and climate change was described by McBean & Motiee for China, Iran, and Canada. China has an average of 648 mm rainfall per year and in the north there is only 500 m^3 per person per annual whereas in the south it is 20000 m^3. Over 400 out of 668 cities are facing water shortages and over 100 have serious shortages. In Iran the population has grown from 20M in 1955 to 70M by 2005. A lack of water management, periodic drought and villages being buried beneath sand, point to serious problems. In Canada, Lake Superior has dropped by about 50 cm below its 81-year average level, much of which has occurred since 1980.

The use of local data in estimating and predicting extreme floods was presented by myself, starting from the poor estimation of the PMF on the upper Brue: flood inundation maps show that the PMP + dambreak flood has been exceeded four times in the past 240 years. As a result the spillway design flood has been doubled, resulting in a £3M remedial works. For the river Valency at Boscastle in Cornwall, the 70-year flood

has been underestimated by 35% leading to an under-designed flood scheme. Estimates of SMD using MOSES have considerable errors, while NIMROD radar data are underestimated for the period 2004–2005 in East Somerset. Hence local data must be used carefully and more often. I also presented **assessing spillway design flood and the collapse of Gasper dam, June 29 1917.** Gasper dam was rebuilt in 1920 and has been inspected five times since 1978. The inspection report of 2004 states that the PMF is 59 cumecs and that the dam will not be overtopped below the 1-in-10000 year event. Both statements are incorrect. The ICE rapid method gives a PMF of 71 cumecs; the FEH gives 86 cumecs while revised PMP estimates and a non-linear model give a result of 146 cumecs. During the last 30 years there have been two minor overtopping events. In both cases the culvert, which passes through the dam, was not blocked.

Floods and its aftermath…on the U.Mississippi, Missouri and Illinois river in the USA was presented by Bhowmik. The flood of 1993 was described as breaching 69% of the levees on the Mississippi and Missouri and causing about $13Bn damage. The flood of 2008 was considerably less severe. On the other hand the floods of 1785, 1844, 1850, and 1855 exceeded the 1993 flood at St Louis. The weight of the herbicide atrazine entering the Gulf of Mexico was 539 000 kg between April and August 1993 which was 85% and 235% higher than the same period in 1991 and 1992 respectively.

Reconciliation of future water demand and supply in W. Sydney, Australia by Singh *et. al*. predicts that by 2025 the population of South Creek catchment (area 625 km^2) will increase from 323–764 × 10^3. This could lead to unsustainable water demands where the AAR = 683 mm. Water is used for domestic and irrigated crops. Therefore strategies have to be adopted to stop water shortages. These include the replacement of potable water with non-potable water for laundry and toilet use in new dwellings (21% drop); recreational water usage; and residential outdoor use in new dwellings. For existing dwellings there could be a 16% reduction in potable water demand. At present, people use over 400 l/day, so there is much scope for reducing demand.

Predictive uncertainty in hydrologic & water quality modelling was the theme of Hantush, Kalin, & Govindaraju who described the use of GLUE, Bayesian, Pareto and Kalman filter methods to estimate *model uncertainty* (– my emphasis). They conclude by stating challenges for the future such as being unable to quantify the relative importance of each part of model uncertainty; finding a cheaper method than Monte Carlo procedure to evaluate uncertainty; data collected by indirect means is also uncertain (remote sensing data); future land use may change and its effects need to be accounted for; model uncertainty needs to be integrated with economic and societal benefits; better representation of processes should aim at reducing uncertainty.

Water balance assessment of a river basin through system simulation was described by Reddy & Jain for parts of the Godavari basin in peninsula India. The proposed Inchampalli project is multipurpose. The Software for Reservoir Analysis model was developed at NIH Roorkee. River flows at the project site were used. The results showed that the project can generate its planned 117 MW power with 92.5% reliability. Irrigation demand can be met in 80% of the years. Higher levels of power demand are met with less reliability. The surplus volume behind the proposed dam was also estimated at the 75% reliability standard.

Assessment of drinking water quality in Delhi city was described by Gupta, Chaturvedi & Bassin. The results showed that pH, turbidity, total hardness and chloride were within guideline levels. No samples contained total or feacal coliform. In 10% of samples, coliform bacteria exceeded 10. Feacal coliform were found in 4.1% of samples. Water gets contaminated in the pipework even though it was treated. This could be because of intermittent supply, the use of inline booster pumps, and leakage.

The emerging challenges of groundwater quality as described by Tyagi are the control of point and non-point contamination. Methods are the delineation of the protection area, survey of land use, identify the sources of pollution, implement the well-head protection policy (WHPP). Four case studies were in the USA: at Palm Beach County, Florida, the wellhead protection criteria were the 30-, 210- and 500-day time of travel and also the one-foot drawdown to place. In the Descanso district California, a pumping rate of 75 gallons/minute, a transmission rate of 360 cubic ft/day, and a storage

capacity of 0.02 were used to estimate the wellhead protection area.

Water, environment, energy and society – interaction and interdependence was the thought-provoking paper presented by Jain & Singh. Indian scriptures tell us that the human body is made up of soil, water, fire, sky, and air. These elements are very important to Indian society. Water needs careful management: in the case of the Danube, which flows through 18 countries, the water is shared sensibly. But disputes in other areas have happened and will increase in the future. Environmental influences on water supply must be taken seriously. Water-borne diseases kill two million people every year, 90% of which are children under 5 years old. Women need and use water the most; they have much knowledge about water storage, use and management but often this knowledge is overlooked. Less time spent on collecting water means more time spent on childcare and education. The place of religion in water use must not be overlooked: in Islam: "Heavens and earth were joined together – we made from water every living thing." Hinduism advocates simple living – a model for sustainable economies.

Optimisation of hydropower in a multi-objective context for the Hoa Binh reservoir in Vietnam was described by Rosbjerg, Ngo, & Madsen who used the hydrodynamic simulation MIKE-11 model. They also used the shuffled complex evolution algorithm with MIKE-11, with optimisation, to show that more hydropower could be generated without loss of downstream flood protection. For the period 15–22 August 1996, an extra 5.5 GWh power generated over and above the previously used optimised rule curves could have been generated. This is one advantage of a flow prediction system, especially if it is real time.

Reliability in the estimation of ET_o using minimum climatological data was the theme described by Nikam, Kumar, Khare & Chaube. They used 10 years' data 1991–2000 and five methods to estimate potential evaporation; open pan data were used as the standard. Details of the pan design were not given. The results showed that the Penman-Monteith method came out best, followed by Turc, Priestly-Taylor, Hargreaves, and Thornthwaite methods. If the basis for comparison is the pan then why bother with measurements of temperature, RH, wind, and sun?

Long-term intergrated water-management in the German river Elbe basin was described by Becker. The problem is complex, with working out the strategy, discussion with stakeholders, management effects, comparison of results and negotiation, leading to decision making. The methodology was applied to the Spree-Havel river in E.Germany. Results showed how the managed and unmanaged water resources were considerably different, such that new policies have to be implemented. In the wetland area of Preewald the effects of different management options are a useful basis for discussion with local people.

Mapping of evapotranspiration zones in India using GIS was described by Giridhar, Satyanarayana & Viswanadh. The Penman-Monteith method of estimating potential evaporation was applied to 167 Met. Stations. Using GIS 9.1 software, maps for each month were prepared. There was no key for these maps but it is clear that potential evaporation varies considerably from April–July as compared with October–December. No attempt was made to verify the results.

Modelling the effects of rural land management on flood risk was described by Wheater, McIntyre & Jackson. In the UK, extra pressure on the land has led to a loss of soil structure: sheep numbers are up six-fold and the weight of each animal has doubled. Local farmers have noticed that river flow has increased. The Pontbren catchment in mid- Wales has been instrumented for runoff, rainfall and climate variables. Both catchments and selected plots have been measured for soil properties. For 2005–2008, model simulations show that tree shelter belts can reduce flood peak and afforestation gives an even higher reduction.

My attendance at the conference was only possible because of grants from the Royal Meteorological Society and the British Hydrological Society for which I am very grateful. It is hoped that a CD of the conference proceedings (four volumes), will be available soon.

Colin Clark

Science and information technologies for sustainable management of aquatic ecosystems

International Conference, Concepción, Chile 12-16 January 2009

This meeting represented the first joint meeting of the 7th International Symposium on Ecohydraulics and the 8th International Conference on Hydroinformatics. The Ecohydraulics conference series was first held in 1992 in Trondheim, Norway, to focus on developing and applying linkages between physical processes and ecological functions in aquatic ecosystems. The conference typically attracts researchers studying the interactions between hydrology, hydraulics and geomorphic processes with ecological processes. The Hydroinformatics conference series was started in 1994 in Delft, The Netherlands, to support the growing number of researchers using advanced information and communication technologies to study the equitable and efficient use of water resources.

Recent advances in both of these fields, as well as changing legislative requirements, have highlighted the need for integration and collaboration between these disciplines to model and predict the ecological consequences of natural and anthropogenic changes on water resource management. Keynote speeches focused on recent interdisciplinary approaches to water resource management.

Arthur Mynett, (Delft Hydraulics), highlighted that legislation has become a key driver for integration and collaboration between Ecohydraulics and Hydroinformatics, as only such collaboration can provide the decision support and integrated models needed to implement recent legislation such as the Water Framework Directive. This was supported in a keynote speech by **Peter Goodwin** (University of Idaho) who stated that emerging community science needs have produced problems which are too large and complex for traditional university consortia, prompting recent policies of open source codes and data sharing which have promoted trans-continental collaboration.

Inspiring examples of collaborative research were provided by further keynote speeches, including **Jack Stanford** (University of Montana), who outlined the tendency for ecosystems to 'self-organise' physically and biologically, due to the underpinning physical laws by which they are bound. Such organisation was shown to occur in recent studies examining changes in energy gradients from the headwater to estuary using an Acoustic Doppler Current Profiler in temperate rivers of North America. This work highlights the synergy of biological and physical processes which operate within river catchments; a key tenet of ecohydrological research.

John Dracup (University of California, Berkeley), highlighted the impacts of climate change on high elevation hydropower generation in California. Using computer simulated models of climate change scenarios, it was shown that an increased occurrence of heat waves later in the summer, as predicted by the climate change model, would increase peak power demand at a time when these systems would be at low capacity due to hydrograph changes also resulting from climate change. Such simulations have highlighted the need to modify operating strategies to meet changing needs.

John Nestler (US Army Engineer Research & Development Centre, USA) provided an insight into his fascinating research into 'hydro-navigation' by large fish in the Mississippi River. Dr Nestler and his colleagues have shown that these fish appear to be responding to velocity distortions (measured

using hydraulic strain and velocity magnitude) resulting from changes in fluvial geomorphology, water flow and stage and bio-geochemistry, to navigate between spatially and temporally heterogeneous resources within rivers and floodplains. This research raises a number of concerns regarding large river restoration which were later discussed by **Claudio Baigun** (Universidad de San Martin, Argentina) who highlighted the importance of annual flood pulses in driving carbon metabolism and nutrient fluxes required by native biota such as the sabalo (*Prochilodus lineatus*) in the near pristine Middle and Lower Parana River, Argentina.

The conference also provided me with the opportunity to present my own research which focuses on examining how geomorphological complexity develops following glacial recession in Glacier Bay National Park, south-east Alaska. My research indicates that geomorphological complexity plays an important role in determining the amount and quality of instream habitat available to biota, linking changes in hydromorphology to habitat utilisation by salmonids.

Meeting colleagues from a number of organisations and disciplines during the conference gave me invaluable insight and support to my research. In particular, I discovered information on novel numerical modelling programs, which will add a new dimension to my research, thus leading to continued collaboration between Ecohydrology and Hydroinformatics.

Megan Klaar
University of Birmingham

Hydrology Research

The latest issue of ***Hydrology Research*** (Vol. 40, no. 1) contains the following seven articles:

Estimating soil thaw energy in sub-Alpine tundra at the hillslope scale, Wolf Creek, Yukon Territory, Canada.
T. Shirazi et al.

Geochemical and isotopic evolution of high-pH groundwater in a carbonate-bearing glacigenic aquifer, SW Finland
Nina M. Kortelainen and Juha A. Karhu

Laboratory test of snow wetness influence on electrical conductivity measured with ground penetrating radar
Nils Granlund et al.

Wind-adjusted Turc equation for estimating reference evapotranspiration at humid European locations
Slavisa Trajkovic and Srdjan Kolakovic

Water mixing processes within a crystalline massif: Sudety mountains, SW Poland
Bart omiej Rzonca and Sebastian Buczy ski

GA-optimized model predicts dispersion coefficient in natural channels
Gokmen Tayfur

Analysis of drought and storage for Mula project using ANN and stochastic generation models
Taymoor A. et al.

No British authors in this issue of our co-sponsored journal (*what a shame - Ed.*) but please note the forthcoming Special Issue:

Modelling Impacts of Climate and Environmental Change on Freshwater Ecosystems,

Guest edited by Paul Whitehead, Oxford University Centre for Water Research.

For further information such as current contents and how to submit a paper, follow the links from our web site.

New members

Tom Ball .....Dundee University
Shane Carey.....Westmeath, Ireland
Burt Clothier.....Robinson & Noble Inc., USA
Charlotte Davison.....JBA Consulting, North Yorkshire
Laura Errington.....Aarduark EM Ltd., Somerset
David Vaynor Evans.....Hydro-Logic Ltd., Stirling
Daniel Farrow..... Mouchel Servers Ltd., Bradford
Nathan Forsythe.....Newcastle University
Lucy Fryer.....Edinburgh University
Gillian Garbett.....Enviroment Agency, Cheshire
Harry Gibson.....Haycock Associates Ltd., Worcs
Emily Gordon.....Environment Agency, Oxford
Sahana Harun.....Birmingham
Nichiolas Haycock.....Haycock Associates Ltd., Worcs
Peter Horne.....Hydro-Logic Ltd., Stirling
Anthony Hurford.....HR Wallingford Ltd
Christian Imholt.....Aberdeen University
Mari Jones.....Newcastle University
Claire Elaine Maddison.....Ellesmere Port
Debbie Martin.....Environment Agency, Cheshire
Celia Menard.....Edinburgh University
Graham Moralee.....ENTEC UK Ltd., Gostorth
Andrew Murcott.....Environment Agency, Warrington
Rachel Myers.....Reading
Simon Parry..... ..CEH, Wallingford
Elizabeth Rewcastle.....Capita Symonds, East Grinstead
Amy Reynolds.....Haycock Associates Ltd., Worcs
Mark Richard Roberts....Haycock Associates Ltd., Worcs
Henry C Smith.....Haycock Associates Ltd., Worcs
Celia Svensson.....CEH, Wallingford
Michael Swallow.....Environment Agency, Pevensey
Catherine Treagus.....Grontmij, Warrington
Kirsty-Anne Wilson.....SEPA, Dundee
Ashley Woods.....Haycock Associates Ltd., Worcs

DEFRA consultation

Defra has published its draft Flood and Water Management Bill, designed to improve how we prepare for and respond to flood emergencies and better protect water supplies during drought. The draft Flood and Water Management Bill consultation documents can be found at **http://www.defra.gov.uk/environ/fcd/floodsandwaterbill.htm.** The consultation will be open until **24 July**. If any member has comments on any part of the draft that they would like to be incorporated in an official BHS response, please let me know.

Celia Kirby

IWA's latest Publications catalogue is available to download from their web site and includes several new 'water' books:

Climate Change and Water: International Perspectives on Mitigation and Adaptation

Private Sector Participation in Water Infrastructure

Managing Water for All

Basic Water Treatment

Environmental Technologies to Treat Nitrogen Pollution

If you'd like to know more, go to **www.iwapublishing.com**

Editorial

This issue is packed with meetings reports. We think its important to do our bit to enhance the information network in this way as time and money for travel to meetings is in short supply. Hopefully, if this helps you to identify authors and their research, you can follow up your interests through other channels.

John Griffin and I have been busy with the BHS web site, including giving thought to other things to include. Some years ago there was talk of BHS producing a 'hydrologist's toolbox' and the Committee are re-visiting the concept which should now be a web item, not a publication. Meanwhile, we are looking again at the existing spreadsheet on data sources and checking the validity of the WMO's 'Hyperlinks in Hydrology' database.

Celia Kirby

BHS Student Award for 2009

● First Prize £400 ●
● Two Runner-Up Prizes of £200 each ●

Nominations are invited from all UK university departments with an interest in hydrology at the undergraduate level. Only one outstanding dissertation, commended by the student's supervisor, may be nominated per department.

Prizes are awarded on the achievement, relevance, originality and presentation of submitted final-year dissertations addressing scientific and applied issues in hydrology, judged by a panel drawn from the BHS Main Committee. Dissertations must be submitted by 17th July 2009.

For further details, please contact our Honorary Secretary, Claire Walsh, email claire.walsh@ncl.ac.uk

HELP WANTED!

We try and be efficient in the running of the Society and hope that our record-keeping is up to date. One of the advantages of using electronic mailings wherever possible is that we get some idea when things are not delivered (not always the case with ordinary post).

However, some recent mailings - the Register of Consultants and the Membership Directory, for example, resulted in quite a few 'returns' and we'd like to enlist the help of members who may be able to let **Tim Fuller** know where these people are located so that we can update our contact details. You can reach Tim at bhs@ice.org.uk or Tel: 0207 665 2234.

Miss Zoe Barnes (email not working)
Miss Philippa Clegg (post returned)
Mr Phillip Connelly (email not working)
Dr Jacqueline Cotton (Post returned)
Mr Mark C Franklin (email not working)
Miss Helen Godrey (email not working)
Dr Gemma Harvey (email not working)
Mr John A Kay (email not working)
Mr Robert J McInnes (email not working)
Ms Sue Moore (post returned)
Ms Helen Murray (email not working
Miss Abigail R Pryce (email not working)
Mr Andrew Rebeiro-Hargrave (post returned)
Mr Matthew Richard (email not working)
Mr Mathieu Roy (email not working)
Ms Lucy Shuker (email not working)
Mr Jonathan WN Smith (email not working)
Miss Helen L Tapley (email not working)
Mr Oliver M Taylor (email not working)
Dr Roger J Wade (email not working)
Mr Julius Wellens-Mensah (email not working)
Mrs Lisa J Worledge (email not working)

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. Applicants should have been members of the Society for at least six months. The amount will depend on the nature and location of the meeting and the case put forward.

Priority is given to members under 35 or retired from employment, who are presenting papers and who have not previously received support from BHS. Successful applicants will be expected to write a short report for *Circulation*. Travel grant applications should be made to the Hon Treasurer at least two months before the conference or meeting.

The Exeter Fund, administered by the Society, offers grants to British hydrologists to take part in IAHS / IUGG events.

To apply, use the form at *www.hydrology.org.uk/about_awards.htm* or contact **Peter Ede**, Mott MacDonald Group, Demeter House, Station Road, Cambridge, CB1 2RS *(tel 01223 463690, email peter.ede@mottmac.com).*

Training course

The University of Leeds is specialising in professional ethics training, and have developed a one-day workshop to help professional engineers manage any ethical issues they may encounter in their working lives. As well as helping to deal sensitively with the kinds of workplace dilemmas where personal and organisational ethics may play a role, this training will also help with CPD generally, and specifically with progression towards chartered or incorporated status, particularly with relation to Category E of the UKSpec.

For more information about the course, please follow this link:

www.idea.leeds.ac.uk/proeng

Diary

8th June 2009
"Developing best practice in water resources planning"
Joint BHS/CIWEM meeting
Venue: ICE London
Contact: frank.farquharson@btinternet.com/Tel: 01491 871547

16th June 2009
"Sustainable flood risk management in Scotland: implementation and key legislation"
Venue: Edinburgh
Contact: www.holyrood.com/flooding

17 June 2009
"Integrated urban drainage" (including site visit)
BHS South East Section
Time: 10.00
Location: London
Contact: Helen Procter (Tel: 01372 756478)

18–19th June 2009
Peter Wolf Young Hydrologists Symposium
Venue: University of Liverpool
Contact: Neil Macdonald (neil.macdonald@liverpool.ac.uk)

29th June–2nd July 2009
"Meteorological Science in time and space - from local weather to global climate"
Conference organised by Royal Meteorological Society
Venue: University of Reading
Contact: Sue Brown (Tel: 0118 956 8500)

9th July 2009
"Peat hydrology - the current and future role of peat in hydrology"
BHS National meeting
Venue: University of Newcastle
Contact: claire.walsh@ncl.ac.uk

3rd–17th July 2009
Unesco Workshop: "Modelling for adaptive water resources management"
to be held at the 18th World IMACS Congress
Venue: Cairns, Australia
Contact: www.mssanz.org.au/modsim09

7–9th September 2009
7th International Conference on River Basin Management
Venue: Malta
Contact: www.wessex.ac.uk/rbm2009rem1a.html

BHS Third International Symposium
Newcastle University
2010

Planning is now well advanced for this event. Please put the dates in your diary and watch for further updates on the web site.

2010 British Hydrological Society
newcastle university

Copy deadline for Circulation No. 102
17th July 2009