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THE NEWSLETTER OF THE BRITISH HYDROLOGICAL SOCIETY

Circulation

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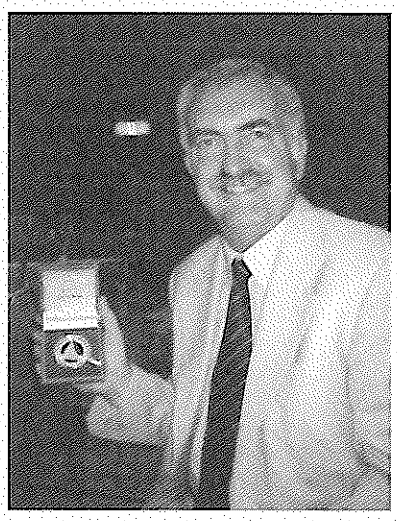
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Hydrology at IUGG in Japan

The BHS Exeter Fund supported several members to attend the IAHS events at the 23rd IUGG General Assembly in Sapporo: we have two reports on the proceedings.





Also at Sapporo, ***Dr Alan Gustard*** *received the International Hydrology Prize from IAHS President* ***Prof. Kuniyoshi Takeuchi****. Alan recently retired as Deputy Director at CEH Wallingford and is only the second British hydrologist to win this prize, which was awarded for his contribution to international hydrological research, notably UNESCO's FRIEND programme. The citation, and Alan's reply, are on the IAHS website* (http://www.cig.ensmp.fr/~iahs/IHPrize/gustard.htm).

IAHS Assembly: workshops on MOPEX and PUB

XXIII General Assembly of the International Union of Geodesy and Geophysics, Sapporo, Japan July 2003

The International Association of Hydrological Sciences General Assembly ran from 3rd to 11th July as part of the IUGG General Assembly. There were twelve IAHS symposia and workshops, covering water resources, distributed modelling, isotope tracers, model parameter estimation experiments (MOPEX) and prediction in ungauged basins (PUB), amongst other themes. I review here a few memorable contributions to the PUB and MOPEX workshops, plus other highlights of the Assembly.

Thanks partly to a BHS travel grant, I attended the Sapporo Assembly and participated in the MOPEX and PUB workshops. MOPEX is an established international research initiative led by **John C. Schaake** (formerly of the US National Weather Service) aimed at improved parameter estimation methods for hydrological and atmospheric modelling.

PUB is a relatively new IAHS research initiative [see *Circulation 76*, p. 19], aimed at developing techniques for modelling the hydrology of ungauged basins. The steering group is chaired by **Murugesu Sivapalan**. One important outcome of the Assembly was the identification of common themes, collaboration and entente between the PUB and MOPEX programmes.

Harald Kunstmann, **Kuniyoshi Takeuchi** and **Yeugeniy Gusev** presented three examples of the powers and limitations of using physically-based models. Gusev argued that calibration was not necessary for his model of a Siberian catchment, although his snow interception module included empirical parameters. Takeuchi accepted that his BTOPMC model needed calibrating, and that it had taken the SCE algorithm 14 days to converge to the optimum parameter set. It was clear from Kunstmann's work that the data required for useful calibration of a distributed model were well beyond that generally available. **Johan Andreassian** pointed out that simpler conceptual models were more useful in engineering applications.

Semi-distributed models also received attention. **Fekadu Moreda** (US National Weather Service) described a process for calibrating parameters of the lumped CONT-API model, then downscaling to a 4 km^2 grid size using a regionalisation procedure. **George Leavesley** (USGS) described a toolbox, containing various models and parameter estimation techniques, with which he optimised parameters within the semi-distributed PRMS model.

Model error diagnosis was another theme. John Schaake introduced wavelet analysis and analysis of seasonal parameter variability as diagnostic tools. **Thorsten Wagener**, **Hoshin Gupta** and myself all highlighted the relevance of recursive parameter estimation, particularly Wagener's new DYNIA method.

Jeff McDonell went on to lead a discussion about the importance of using isotope and chemical tracers to identify model structural faults. In his PUB presentation, **Stephan Uhlenbrock** described the use of tracers for approximating slow and fast response residence times. Wagener and Gupta both emphasised consistency issues in conceptual rainfall-runoff modelling, implying that parameters should not be identified solely on the basis of model fit to observed data, but should also represent the processes they were designed to represent, otherwise parameter values cannot safely be extrapolated in time and space.

The importance of consistency also surfaced when **Norman Peters** talked about integrating hydrological and water quality models, where internal workings of the hydrological model (rather than just the streamflow output) are crucial. Other contributors later pointed to the role that hydrological theorists, meteorologists and ecologists, as well as experimentalists, can play in resolving modelling problems.

Keith Beven reminded the MOPEX workshop that all their models and data are "wrong and known to be wrong" and that the relevant issue was whether the models and data, given the uncertainties, were useful. He introduced a calibration procedure whereby model and model input realisations could be disqualified if they failed to replicate the known range of behaviour of the modelled hydrological system. The introduction of initial condition and boundary condition errors was presented as an extension of the established GLUE procedure. **Dimitri Kavetski** pursued the uncertainty topic, introducing his BATEA method of parameter estimation, and demonstrating the bias introduced to parameters by input data random error. In the PUB session, Keith Beven previewed the difficulty of coping with uncertainty in very large distributed models, which are likely to become prevalent for ungauged basin problems.

Günter Blöschl (TU Wien), **Andy Young** (CEH Wallingford) and myself outlined regionalisation studies. Blöschl applied a lumped model to 500 catchments in Austria, optimising the parameters to each catchment using a single objective function. He concluded that topography was the main control on parameters, and spatial proximity could be used as a surrogate for this. Young regionalised the probability distributed soil moisture model using a database of 277 UK catchments, and applied the results to UKCIP climate change scenarios, showing that future scenarios may be dominated by regional model uncertainties, especially when model parameters are highly covariant. He also introduced the regionalisation software used by the Environment Agency in the UK to assess the effects of abstractions upon natural low flow regimes. I presented Imperial/CEH research into the role of model structure selection in regionalisation, with the conclusion that there is not yet evidence that catchment characteristics should dictate conceptual model structure selection.

Aside from the workshops, there were two IAHS plenaries (plus a series of IAHS Commission meetings). At the first plenary, Kuniyoshi Takeuchi, President of IAHS, set out the IAHS Central Agenda – attracting more young scientists from developing countries to participate in IAHS, raising the profile of IAHS and developing the PUB initiative. To enthusiastic applause, he reported that the IAHS *Hydrological Sciences Journal* is now ranked 5th in the Water section of the ISI Journal Citation Report.

The Tison Award was awarded to Japanese hydrologists **Taikan Oki**, **Yasushi Agata**, **Shinjiro Kanae**, **Takao Saruhashi** and **Dawen Yang** for their *HSJ* paper "Global assessment of current water resources using total runoff integrating pathways". The International Hydrology Prize went to

Alan Gustard (CEH Wallingford) for his "long-standing contribution to the development of international hydrological research programmes".

At the second plenary, the President of the IUGG, **Uri Shamir**, gave a fascinating insight into the topic of international water disputes, particularly those in the Middle East. There are 261 internationally shared rivers in the world, but there have been only seven acute conflicts over water, and no wars. "For those seeking conflict, water can be a cause; for those seeking reconciliation, water can be a bridge," was Shamir's declaration, reflected in his positive account of the difficulties that Israel, Jordan, Palestine and Lebanon have worked together to resolve, and of the challenges that they are confronting jointly.

Hosted with Japanese efficiency and grace, and managed with skill and patience by the conveners and IAHS staff, the Assembly was a huge success and a pleasure to attend, and we already have good reason to look forward to the next IAHS Scientific Assembly in Brazil in 2005.

Neil McIntyre
Imperial College London



IUGG2003 flags welcoming conference delegates to Sapporo

International stream temperature workshop

XXIII General Assembly of the IUGG
Sapporo, Japan
11 July 2003

The quadrennial IUGG General Assembly is one of the largest earth and space science conferences, and over 4000 delegates attended the 23rd meeting in Sapporo during the first week alone. IAHS is one of the seven Associations of the IUGG, and most IAHS events were held in the second week (7-11 July), including four international symposia and eight workshops.

Given the overlap in subject matter between the Union's Associations, a number of Joint Association symposia and workshops were held, plus six Inter-Association symposia on the "State of the Planet: Frontiers and Challenges". Sushi-Lunch Lectures in the atmospheric and related sciences added to this interdisciplinary mix. So, there was a wide range of sessions of core interest to hydrologists, as well as the opportunity to learn about methodologies, results and hypotheses across our discipline's interfaces with other sciences.

It is a difficult task to choose papers to highlight from this array of symposia and workshops. Therefore this report focuses upon the *International Workshop on Stream Temperature Change and Effects* (IAHS-HW02). Abstracts for all papers and posters are still available on the IUGG2003 website: *http://www.jamstec.go.jp/jamstec-e/iugg/* (though they require a bit of searching for there).

BHS President-Elect **Bruce Webb** (University of Exeter) convened this workshop, which comprised eight oral presentations and two posters dealing with various aspects of stream and river temperature research. The main themes included physical processes of heat exchange, understanding thermal variability at a range of scales and in different environments, ecological implications, human effects and management issues, and water temperature prediction. Bruce began by welcoming the audience and said how appropriate it was to hold this workshop in Japan, where one of the first dedicated laboratories to stream temperature measurement was established.

Bruce Webb presented the first paper (co-author **Yu Zhang**), which considered seasonal variation in the non-advective components of river heat budgets for four contrasting streams (exposed moorland, regulated, deciduous woodland and coniferous forest) in south-west England. Based upon detailed hydrometeorological observations above these streams (May 1995 – April 1996), contributions from radiation (net, short-wave and long-wave), sensible heat, latent heat, bed conduction and friction at the stream-bed and banks to stream energy gain and loss were quantified. Monthly values were reported which showed marked seasonal patterns in energy flux magnitude and partitioning for all sites. Most notably, the paper clearly highlighted inter-site variations in energy budget components and emphasised the influence of stream characteristics upon the seasonal progression in heat budget terms.

My paper with co-authors **Iain Malcolm** (Fisheries Research Services), **Chris Soulsby** (University of Aberdeen) and Alan Youngson (Fisheries Research Services) continued the theme of heat transfer processes, but focused on a different environment: a sub-arctic, Cairngorm stream. Hydrometeoro-logical observations over the salmon spawning to hatch period (October 2001 – April 2002) were used to characterise seasonal and sub-seasonal patterns in water column and stream-bed temperatures, and energy fluxes at the air-water column and riverbed interfaces. The salient findings of this research (*cf.* previous studies) were: (1) the stream bed (atmosphere) was the dominant energy source (sink) for heating (cooling) channel water, due to heat advection by groundwater up-welling into the streambed; (2) sensible heat was the primary atmospheric energy source due to limited net radiation, which may be explained by the northerly latitude of the field site and time of year; (3) friction at the stream bed and banks was an important heat source, accounting for 24.3% of energy gain.

Andrew Whitaker (co-author **Hironobu Sugiyama**, Niigata University) provided a Japanese perspective by presenting stream

temperature data from a steep, forested basin in the Asahi Mountains of Niigata Prefecture. His paper employed stream, springhead and soil temperatures as indicators of catchment hydrological functioning. Seasonal changes in stream temperature were controlled by strong variations in the climate but also by heavy rainfall and snowmelt periods. During flood events, stream temperature dynamics were explained by the dominant runoff generation mechanisms. For example, short-lived drops in stream temperature were identified for snowmelt events but also high flow events during the warm rainy season when the water table was high and subsurface flows significant. In contrast, other summer rainstorms caused a rise in stream temperature due to the apparent dominance of surface or near-surface flow paths.

Still with mountain environments, I presented a paper (co-authors **Lee Brown** and **Alexander Milner**, both University of Birmingham) that investigated water column and streambed temperature dynamics for different alpine stream types (glacial, snow-fed, springs and hillslope tributaries). Water column and streambed temperatures were recorded at eight and three sites respectively, across a glacierized catchment in the French Pyrénées over the 2002 melt season. Except for streams fed directly by deep groundwater and at the glacier snout, water temperatures were strongly influenced by air temperature and inputs from tributaries. Bed temperatures in the glacial (hillslope, groundwater-dominated) stream were on average coldest (warmest) and most (least) variable. Streambed temperatures were affected by inferred groundwater-surface water interactions. In the lower valley, a glacier-fed stream exhibited limited vertical thermal dampening, indicating surface water downwelling, whereas a hillslope, spring-fed stream showed colder streambed than water column temperatures, suggesting groundwater upwelling. These stream temperature patterns could have certain implications for the distribution and diversity of macroinvertebrate taxa in alpine catchments.

During the mid-session break, two posters were presented informally over coffee: one by Bruce Webb (co-author **Franz Noblis**, Bundesministerium für Land- und Forstwirtschaft, Vienna) on *"Water temperature variation in Austrian rivers during the Twentieth Century"* and the other by myself on *"Exposed riverine sediment patches: energy fluxes and thermal profiles"*.

The session resumed with Bruce Webb giving a paper (co-authors **Paul Clack** and **Des Walling**) on estimating water-air temperature relationships and the moderating role of river flow. Hourly, daily and weekly mean temperature data were presented for (sub-)catchments from 2.1 to 601 km^2 in the Exe basin. Models (linear regression and non-linear logistic functions) were developed for each time-base. Water-air temperature relationships became stronger as data resolution coarsened. The explanatory power of hourly water-air temperature regression models was improved by incorporating a time lag, which increased with catchment area. However, significant departures from linearity in water-air temperature relationships were evident for hourly data. Water-air temperature relationships were more sensitive below median flow, and regression showed that water temperature was inversely related to discharge at all catchment scales. Discharge was most powerful in predicting water temperature at shorter time-scales and in larger catchments.

Takashi Gomi (co-authors **Dan Moore** and **Amod Dhakal**, University of British Columbia) presented results from a well-planned set of six-year field experiments across 12 streams in coastal British Columbia, aimed at assessing the impact of forest harvesting upon headwater stream temperatures. Specifically, they investigated the effectiveness of different widths of forested riparian buffer-strips in protecting stream thermal conditions (by providing shade). Regression analysis was used to calibrate the pre-harvest data for each buffer treatment against one of the control streams, to provide a basis for estimating post-harvest stream temperature effects. Streams with 10 m and 30 m buffers showed no significant post-harvest warming. For streams with no buffer, summer temperature increases averaged just 2–3°C (*cf.* >7–10°C reported in previous studies) due to the incised, narrow streams and partial shading by the remaining under-story.

Koshi Yoshida (co-author **Hajime Tanji**, University of Tokyo) had applied the US Fish and Wildlife Service SNTEMP model to predict stream water temperature change following dam construction. SNTEMP is a mechanistic, one-dimensional heat transport model that predicts the daily water temperatures as a function of stream distance and environmental heat fluxes. The model was run for three key nodes: two upstream and one downstream of the Nam Theun Dam in Laos. The model output clearly showed a reduction in stream temperature variability downstream due to the buffering capacity of the reservoir.

Catherine Ikhile (co-author **Stella Akhionbare**, University of Benin / New Grass Technology, Nigeria) gave the final paper of the workshop, describing stream temperature and dissolved oxygen variations in seven tropical rainforest streams in Edo State, south-west Nigeria, for 1987 and 1997. Minimum water temperatures were higher during the wet season (range 25–33°C) than the dry season (range 21–34°), despite reduced energy inputs. She also highlighted the effect of cold Harmattan winds in reducing stream temperatures. Dissolved oxygen was lower during the dry season than in the wet season, as a consequence of reduced turbulence in flow. Inter-site differences in stream temperatures were accounted for by variable shading effects by the forest canopy and stream orientation.

Bruce Webb closed the session by summing up some of the themes raised and thanking the presenters for their contribution to a very interesting and highly diverse workshop.

I am grateful to the British Hydrological Society for providing a travel grant from the Exeter Fund to help me attend this conference.

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New members

A warm welcome to the following new members of the Society:

Lucy A. Dangerfield	JBA Consulting, Atherstone, Warwickshire
Sean G. Furey	Environment Agency West Malling, Kent
Helen Godfrey	Environment Agency, Worthing, West Sussex
Jacquelyn Harman	UK Climate Impacts Programme, Oxford
Gavin Johnson	Southampton
Soma Mukherjee	University of Brighton
Tom Nichols	Environment Agency, Worthing, West Sussex
Michael J. Parett	Dam Diagnosis Consultancy Ltd, Bickley, Kent
Philip Raynor	URS Corporation Ltd, Manchester
Michelle L. Russell	British Waterways, Watford
Stuart D. Smith	WS Atkins, Peterborough
James Stuart	Halcrow, Swindon
Amy C. W. Tavendale	University of Dundee
Kelly J. Watson	University of Nottingham

President's piece

This is my last contribution as your President and therefore provides an opportunity to express my thoughts about the Society and record my appreciation for the service that many members give to it.

A major activity is the preparation for BHS2004, our 2nd International Conference, to be held at Imperial College next July. The response to the call for papers has been excellent, with 396 abstracts received. The conference timetable can accommodate just over half that number as presented papers and posters, so the Convenors, led by **Bruce Webb**, are busy reviewing the submissions and deciding which to accept. The main and local organising committees, chaired by **Howard Wheater** and **Adrian Butler**, are working hard on the detailed planning. They have chosen the Science Museum as the venue for the Conference Dinner.

This issue contains another article on a route available for members to obtain Chartered membership of a Learned Society or Institution. The Royal Meteorological Society will probably appeal to a smaller number of members than some institutions, but if your training and experience has a strong meteorological element you may wish to explore this option with them. Progress in our discussions on routes to membership of ICE remains in abeyance whilst the Institution completes a review of the application process for all applicants and takes a hard look at how it operates and provides services to its members.

The UK in general and BHS in particular are well respected in the international hydrological community, as is well demonstrated by the strong interest in our International Conference, and our National Meetings too always attract a good attendance. It would be easy to conclude that hydrology is alive and well in the UK. But this is only achieved through the voluntary efforts of many people. It is all too easy to take for granted the huge amount of routine work that is involved in running the Society, and we all owe a debt of gratitude to those who undertake various tasks.

Committee members carry out a wide range of jobs for the Society. The Hon Treasurer and Hon Secretary (**Steven Parsons** and **Andrew Black**) have the lion's share of the work, with **Marianne Foster** and **Tim Fuller** at ICE providing invaluable support, for which we thank them. **Jenny Thorne** ably manages the web site on a day-to-day basis. **John Griffin**'s task as Editor is crucial, as *Circulation* provides the regular communication with you, the members.

I have become very aware over the last six years on the Committee that the pressures on members in full-time employment are now very much greater than when the Society was founded two decades ago. As a result many people have less time available to give to the Society. (The Institution of Civil Engineers has also observed this trend.) The Society depends on members' voluntary efforts and this reliance will not diminish unless the Society changes its policy and starts employing paid support in a much greater way than at present. This is not a step we would want to take and would increase subscriptions significantly.

If you now find you have a little time to spare, perhaps following retirement or a move to part-time work, and you would like to help the Society, please consider standing for the Committee or getting involved with a local section. If you would be willing to arrange a meeting or co-ordinate a response to a consultation paper, please get in touch with Andrew Black, our Hon Secretary. Andrew can then build up a register of people to call on for assistance when the need arises.

Celia Kirby and **Steven Wade** complete their terms as elected members this year. So does Steven Parsons as Hon Treasurer, but I am pleased to report that he is continuing for further two years. I am grateful to them, to other committee members over the last six years and to those who continue in office, for the support they have all given me during my time as President, and to all those in the wider membership who assisted me during my time as President and before that as Honorary Secretary.

Peter D Walsh
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BHS Postgraduate Symposium

School of Geography, University of Leeds
14 May 2003

Since the inaugural meeting (in March 1990 at Loughborough), the BHS Postgraduate Symposium has offered an informal environment in which young researchers working across the hydrological spectrum, and at different stages in the development of their projects, can exchange ideas and views. A wide range of topics was covered throughout the day, including 19 oral presentations and 5 posters.

The opening session considered the ecological dynamics of instream flow. **Jo Moodie** (Lancaster) reported on the influence of river spates on biofilms: surface communities that are disrupted during high flows. The disruption has consequences for the local ecological structure, although Jo provided evidence that areas with flashy regimes exhibit 'flow resistant' biofilms. Continuing the theme, **Wendy Monk** (Loughborough) considered the complications of establishing the role of high flows in modifying instream communities. **Dave Mould** and **Patrice Carbonneau** (Leeds) concentrated on fish habitat. Dave provided details of a paired catchment study designed to establish optimum compensation flows for invertebrate, and hence fish, habitat. Patrice offered a geomorphological perspective in examining Atlantic salmon spawning by illustrating remote means of characterising streambed particle structure. The ability to measure and quantify remotely offers a huge impetus to research into the worldwide decline of the species. **Gavin Mummery** (Bristol) concluded the session by stepping out of the riverbed to discuss his work to incorporate vegetation effects into the Estel2D slope hydrology model. The mechanical and hydrological effects are highly significant, particularly for bank stability, and the adapted model could prove useful for areas of poor geomorphological stability.

Posters viewed during the interval highlighted the diversity of the meeting: large-scale impacts of tropical montane forest (**Dom Spracklen**, Leeds); Alpine benthic communities (**Lee Brown**, Birmingham); the hydrodynamic effects of instream



macrophytes (**Rob Schindler**, Leeds), and fluid contaminants and groundwater flow (**Silke Hartmann**, Leeds; **Sion Roberts**, Queen Mary).

This last theme was pursued in the second session when **Hazel Sinclair** (Leeds) considered colloid-related contaminant and nutrient transport. Her approach is to use fluorescent polystyrene microspheres to estimate the quantity and transport distance to compensate for previous underestimation in hillslope transport models.

After lunch the topics moved to the larger scale - although not quite as large as the splendid sandwiches that beat almost everyone! **Graca Carraca** (Salford and Evora, Portugal) outlined her modelling approach for sensible heat flux in urban areas, and its effects on convective precipitation. The model incorporates local meteorological variables and surface roughness parameters to estimate average flux over 1 x 1 km grid squares.

Neil Hunter (Bristol) tested a potential solution to the problem of large-scale flood model calibration to determine the appropriate surface friction parameters. Neil used a GLUE framework to determine the value of different friction parameterisations, ultimately yielding optimum multi-criteria objective functions for calibration. Of course, despite such efforts to predict flood events, serious social and economic problems still arise, and **Andrew Smith** (Newcastle) argued that, unlike hydrological prediction, these losses must be considered on the regional scale.

On a related theme, **Amy Tavendale** (Dundee) examined the new 'sustainable' approach to flood hazard management outlined by the EU Water Framework Directive. The approach includes hydrological, hydraulic, economic, environmental, social and legal aspects — an unenviable but challenging means of comparing flood management practices across the UK.

Peter Walsh (President of BHS) then led a discussion on the role of the Society, with particular emphasis on the needs, and conversely the role, of postgraduates.

The final series of talks, on water resource management, was well placed in the schedule, since many of the topics previously discussed were evident. **David Maréchal** (Cranfield) used the CRASH soil hydrology model to highlight the advantages of using pre-existing data sets. He showed how, by using this approach to develop a conceptual, continuous, daily rainfall-runoff model, CRASH could be calibrated for medium-sized catchments throughout the UK. **Conor Murphy** (National University of Ireland) considered rainfall-runoff model simulations under various climate change scenarios for a number of catchments in Ireland using HYSIM.

On a regional scale, **Helen O'Brien** (Nottingham Trent) discussed the necessary changes to blanket peat management to prevent discoloration of water supplies in Pennine areas. The primary reason for the colour is the release of humic and fulvic acids during the autumnal rehydration cycle, but grazing and burning have exacerbated the problem in recent years.

The final group of papers gave the professionals an opportunity to disseminate their work. **Katherine Roberts**, who led a delegation from Ewan Associates, described the array of local catchment studies she has undertaken for abstraction, ecological modelling and flood management purposes, and how they can be used as real-time validation data for modelled data.

Margaretta Ayoung (British Waterways) gave an insightful and highly informative discussion of water resource modelling on the British canal network. She outlined the recently developed Water Resources Optimisation Model that uses both operational and hydraulic parameters. I think we were all a little surprised at the size of the system and the efforts required to maintain it!

In conclusion, it is hoped that the variety of topics covered at this Symposium encouraged a greater understanding of the contemporary research issues within a more holistic framework than commonly offered by individual research projects. In particular, the inherent links between academic research, professional consultancy and large-scale planning issues were evident — a facet that may have helped those just starting their PhDs to recognise the overall relevance of their work.

Finally, thanks went to the organising committee of **Rob Thomas** (Science Coordinator and website), **Rick Hunt** (Registration Coordinator) and **Rob Schindler** (Events Coordinator) for working hard to make the symposium so worthwhile. The whole experience was relaxed and enjoyable (for the delegates as well as the organising committee!). I thoroughly recommend participation in the next postgraduate event.

Rob Schindler
Fluvial Hydrology Research Group,
School of Geography, University of Leeds

News from members

Fellowship for Howard Wheater

Congratulations to former President **Prof. Howard Wheater** who has recently been elected a Fellow of the Royal Academy of Engineering.

Flood defence appointments

Defra Minister of State Elliott Morley has appointed **Dr Peter Walsh** (BHS President) to the North West Regional Flood Defence Committee for three years from *1st July 2003*.

Professor Roy Ward has been re-appointed Chairman of the Yorkshire Regional Flood Defence Committee for a further two-year term.

Frank Law was re-appointed to the Thames Regional Flood Defence Committee earlier this year. **Dr Paul Holmes** is also a member.

New BHS Welsh Section

BHS members in Wales will be pleased to know that plans are in hand to launch a BHS Welsh Section. For many years, the Welsh Hydrological Group has provided hydrological meetings in Wales, but latterly problems have been experienced in achieving the required support for a viable group – despite the considerable efforts of a number of WHG committee members. The BHS Welsh Section therefore seeks to create a new impetus and continue the valuable work of the now defunct WHG.

This renewed activity is being led by **Bob Vaughan** (Chair) and **Dr Katie Fawcett** (Hon. Secretary), both of the Environment Agency Wales. Planning has now begun to draft a meetings programme and to form a committee: more details will appear in *Circulation* soon. Members with correspondence addresses in Wales will be identified to the new committee for mailing purposes, but other members with interests in Wales may also wish to be kept in touch so that they can receive information from the new group.

Suggestions of meeting topics and offers or suggestions of people to serve on the new committee will be very welcome.

Anyone wishing to get in touch is encouraged to contact the Hon. Secretary in the first instance: Dr Katie Fawcett, Environment Agency Wales, Cambria House, 29 Newport Road, Cardiff, CF24 0TP (tel 029 20770088 ext 6128, fax 029 20466413, email katie.fawcett@environment-agency.gov.uk).

Chartered status for hydrologists – CMet

BHS members who have approached hydrology through a background in meteorology will be interested in the professional status of Chartered Meteorologist (CMet). In most of the leading professions the highest qualification to which a practitioner can aspire is Chartered Status conferred through accreditation by the Learned or Professional Society or Institute which represents the profession. In the profession of meteorology, and for some in certain closely related disciplines such as hydrology, that accreditation is available to be conferred on successful candidates by the Council of the Royal Meteorological Society. The accreditation as a Chartered Meteorologist (CMet) represents a clear statement that you:

- Have achieved the most demanding and rigorous standards of professional knowledge, training and support skills appropriate to your meteorological or closely related specialism
- Maintain a personal programme of continuous professional development which is independently audited and which keeps your knowledge current and experience fresh
- Operate in your professional life to a publicly acknowledged Code of Conduct.

Chartered status can be gained by individuals who are able to show high levels of competence and professionalism in their specialist discipline related to meteorology, and who are committed to maintaining their expertise through continuing professional development.

Once accredited, you are required to demonstrate regularly that you are maintaining your knowledge through an active programme of continuing professional development (CPD) and that you continue to subscribe to the code of conduct. Failure to satisfy the Society on either of these counts can result in the withdrawal of your accreditation.

Chartered Meteorologist status is available to meteorologists world-wide and has been submitted for recognition as a professional qualification throughout the European Union.

Why professional qualifications?

You will probably have entered your profession with a first or postgraduate degree. Your first degree qualifications are, however, likely to be in support subjects such as mathematics, physics, chemistry or computer science and you are unlikely to practise for long in the area of your postgraduate degree. Your degree qualifications will normally be supported by professional training, often provided by your employer and usually of the highest standard. However, such professional training is typically not formally recognised beyond the providing organisation and is not a "transportable" qualification. It will generally not fulfil the statutory qualification requirements of (for example) other EU countries. Neither does it offer any assurance to employers or customers that you have reached a specific level of vocational expertise or professional knowledge, that you are keeping your knowledge current and that you subscribe to a recognised professional code of conduct. By contrast, Chartered status is evidence that you have, and maintain, up-to-date professional knowledge at the highest level and that you abide by declared professional standards.

If you are interested in gaining Chartered status through the CMet route, further information is available at *www.royalmetsoc.org* or from *execdir@royalmetsoc.org*, or contact BHS committee member **Murray Dale** at the Met Office *(tel 01344 854896, email murray.dale@metoffice.com).*

SEPA's window on river levels

Fishermen, canoeists and other river users can now access the latest data on river levels, Scotland-wide, through new Scottish Environment Protection Agency (SEPA) web pages at *www.sepa.org.uk/riverlevels/*.

Information is provided on the web for all Scotland's major rivers, including the Don, Dee, Clyde, Tay and Tweed, as well as some smaller tributaries.

Tim Jolley, SEPA's Hydrology Manager, and former BHS Hon. Secretary, said that the website has been set up in response to requests from river users for this sort of information. The new web pages will provide a gateway to river level and site information from 90 of SEPA's river gauging stations — chosen to represent river conditions in the local area. Links are also supplied to the National River Flow Archive at CEH Wallingford, which offers further data on river catchments, mean flows and area rainfall totals. The SEPA website is updated every 24 hours, allowing users to monitor conditions accurately.

SEPA hope that leisure users will find the site useful when planning where and when to use a river. The site could also assist school and university students studying hydrology.

Estimation of tidal flood risk to Shetland under climate change

Hydrologists' work in flood risk estimation is conventionally regarded as being concerned with the freshwater environment only, yet the demands of real-world problem-solving often provide exceptions to this norm. In this article, Dr David Cameron, Senior Hydrologist (Flood Risk Assessment, Dingwall) with SEPA, outlines the pragmatic approach needed to providing tidal flood risk estimates for the Shetland Islands. In so doing, he illustrates how the common problems of data availability and uncertainty in risk estimation combine with more specific issues — especially the isostatic sinking of this island group.

There are very few data available on present and projected tidal flood risk for the Shetland Isles. At the time of writing there is no indicative map of tidal flooding for Shetland. The same is true for much of the Scottish mainland, where recourse is often made to the 5 m contour line as an indicator of potential future flood risk. Werritty *et al.* (2002) state that, "By 2050 sea levels are predicted to rise by an additional 80–300 mm, which, when combined with future storm surges, could make most of Scotland's coasts below the 5 m contour more vulnerable to flood risk."

However, local knowledge (e.g. Sandison, 2002) suggests that the use of the 5 m contour line may not be readily applicable to Shetland, because of a difference in tide levels between Shetland and mainland Scotland.

Until a detailed study of tidal flooding for Shetland is conducted, and an indicative flooding map produced, it is necessary to produce pragmatic estimates of the tidal flood levels that include estimates of the potential impact of climate change on flooding. This is essential for planning purposes, including flood risk assessment.

This report provides such estimates, illustrating how each of the factors affecting flood levels can be approximated using best available data or estimates.

Available data

Note on choice of Ordnance Datum

The Ordnance Datum regularly used for Shetland is at Lerwick. This datum is adopted for this report. Conversion to the Ordnance Datum at Newlyn, Cornwall (which is used for the mainland UK and the nearby Islands) can be approximated by adding 0.24 m to the Lerwick datum (Fane, *pers. comm.*).

Lerwick Tide Gauge

From 1956 to February 2002, the Proudman Oceanographic Laboratory (POL) operated a tide gauge at Lerwick. This was situated on the inner wall at the breakwater entrance to the small boat harbour, south of Victoria Pier.

During 2002, SEPA obtained a copy of the 1954 to 2000 annual maxima tidal level data for this gauge. Flood frequency analysis of the data (via the fitting of a Generalised Extreme Value, EV3, distribution by maximum likelihood for current climatic conditions) yielded the return period estimates in Table 1. The estimated 1-in-100-year return period tide level (without climate change) is 1.761 m above Ordnance Datum (mAOD) and the estimated 1-in-200-year return period tide level (without climate change) is 1.784 mAOD.

A note of caution should perhaps be applied to the data from this gauge. As it was located on the inner wall of the breakwater, it is possible that this gauge may be unrepresentative of the flood levels caused by storm surges in other more exposed parts of the coastline.

Highest astronomical tides

There are several ports around the coast of Shetland. At each port, tide levels are often estimated with reference to Chart Datum. For most, but not all, of the ports, information is available (from the Admiralty Tide Tables) to convert the Chart Datum tide levels, to mAOD Lerwick (Table 2).

Using data taken from several

Table 1 *Return period estimates for the POL Lerwick tide gauge as based on an annual maximum analysis of the 1956 to 2000 tide data using a Generalised Extreme Value distribution fitted using maximum likelihood.*

Return period (Years)	Flood level (mAOD Lerwick)	Confidence intervals (mAOD Lerwick)
2	1.475	1.437 to 1.518
5	1.585	1.548 to 1.636
10	1.642	1.606 to 1.699
25	1.699	1.637 to 1.780
50	1.733	1.639 to 1.839
100	1.761	1.617 to 1.889
200	1.784	1.589 to 1934

Table 2 *Ports around Shetland taken from the Admiralty Tide Tables, together with the factor for converting from Chart Datum to Ordnance Datum (Lerwick): note that this is unavailable for several ports.*

Place	Easting	Northing	Conversion factor for Chart Datum to Ordnance Datum (Lerwick)
LERWICK	448116	1140866	-1.22
Fair Isle	422622	1071950	-0.92
Sumburgh (Grutness Voe	440110	1111072	not available
Dury Voe	445984	1163113	-1.30
Out Skerries	468833	1170900	not available
Toft Pier	443987	1176083	not available
Burra Voe (Yell Sound)	452180	1179904	-1.24
Mid Yell	452020	1191040	-1.38
Balta Sound	463586	1207934	-1.28
Burra Firth	461674	1213471	-1.37
Bluemull Sound	454588	1202217	-1.37
SULLOM VOE	438508	1174164	-1.40
Hillswick	428394	1177783	not available
Scalloway	440734	1138921	-0.84
Bay of Quendale	437293	1112899	not available
Foula	397221	1136840	not available

sources (POL website; Sandison, 2002, and the TIDECALC software available to SEPA), it was possible to estimate the Highest Astronomical Tide (HAT) for most, but not all, of the ports (Table 3). The ports are shown in Figure 1.

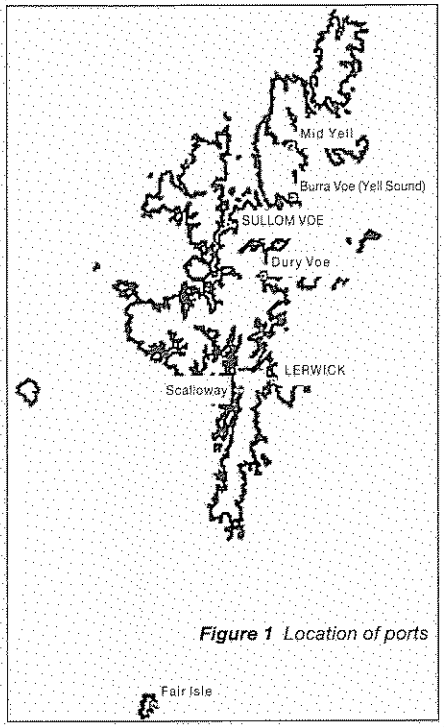


Figure 1 *Location of ports*

Sea level rise and isostatic uplift/recession

The most recent climate change information for the UK as a whole is the United Kingdom Climate Impacts Programme 2002 (UKCIP02) study (Hulme *et al.*, 2002). This produced four scenarios (ranging from "Low Emissions" to "High Emissions") of climate change, based upon different projected inputs of greenhouse gases to the atmosphere over the course of the 21st Century. Each scenario is equally valid, and there is no "right" or "wrong" scenario.

In order to provide a meaningful range of potential rises in sea level, the "Low Emissions" scenario (which estimates a sea level rise for the Shetland Isles of about 0.09 m by the 2080s) and the "High Emissions" scenario (which estimates a rise of about 0.69 m) are adopted here.

In addition to sea level rise, there is a commonly held belief that Shetland is "sinking" as a result of isostatic recession. The published UKCIP02 scenarios did not have data for Shetland for this process, but it has been recently suggested (Brown, *pers. comm.*) that the recession may be of the order of 0.22 m by the 2080s, and this value has therefore been adopted.

Storm surges

The flood risk of a high tide can be significantly exacerbated by storm surges. In the absence of readily applicable storm surge data from UKCIP02, it has been necessary to use to other sources of storm surge information, described below.

In January 1993, Shetland was exposed to a major storm event (associated with the sinking of the "Braer" oil tanker). At the Lerwick tide gauge the level recorded was 1.77 mAOD. Using the TIDECALC software, an astronomical tide level of 1.14 mAOD was estimated for this storm event, which suggests that the storm surge of this event at Lerwick was at least 0.63 m. (It could have been higher, given the location of the gauge behind the breakwater.) For reference, Sandison (2002) indicates that the surge at Scalloway during the January 1993 event was at least 1 m. Dawson *et al.* (2001) suggest that storm surges of up to 1.3 m could be experienced around the Scottish coastline.

On the basis of this information, it is possible to define a possible range of storm surges as being between 0.63 m and 1.3 m. Clearly this is an over-simplification. For example, these values do not take into account the physical nature of the coastline of Shetland, such as at the voes, where funnelling might be experienced, leading to higher wave heights, and thus possibly to higher tidal flood levels than those estimated in this report. However, in the absence of any other information, the approach adopted in this report does at least provide some basis for estimation.

Climate change scenarios

Using the information described in the preceding paragraphs, it was possible to define the following scenarios:

- "Best case" — for each port, the HAT, plus 0.09 m sea level rise (estimated from the "Low Emissions" scenario), plus 0.22 m isostatic recession, plus 0.63 m surge (from the Lerwick tide gauge). For comparison, a 1.3 m surge (from Dawson et al., 2001) is also included.
- "Worst case" — for each port, the HAT, plus 0.69 m sea level rise (estimated from the "High Emissions" scenario), plus 0.22 m isostatic recession, plus 1.3 m (from Dawson et al., 2001). For comparison, a 0.63 m surge (from the Lerwick tide gauge) is also included.

Results and discussion

The results of the "Best" and "Worst" case scenarios are summarised in Tables 3 and 4 and Figures 2 and 3.

For a given scenario, it can be seen

Table 3 *Estimated tide levels for the Shetland Isles for the 2080s: (a) "best case" scenario: estimates are based upon: predicted Highest Astronomical Tide (HAT), an estimated 0.09 m rise in sea level (from the "Low Emissions" Scenario under UKCIP02, Hulme et al., 2002), an estimated 0.22 m isostatic recession (Brown, pers. comm.), and assumed surges of 0.63 m (from the POL Lerwick tide gauge for the January 1993 storm) and 1.3 m (Dawson et al., 2001). (b) "worst case" scenario: estimates are based upon: predicted HAT, an estimated 0.69 m rise in sea level (from the "High Emissions" Scenario under UKCIP02, Hulme et al., 2002), and estimated isostatic recession and assumed surges as in (a) above.*

(a) Place	HAT (mAOD)	HAT + 0.09 m sea level rise + 0.22 m isostatic recession (mAOD)	HAT + 0.09 m sea level rise + 0.22 m isostatic recession + 0.63 m surge (mAOD)	HAT +0.09 m sea level rise + 0.22 m isostatic recession + 1.3 m surge (mAOD)
LERWICK	1.25[a]	1.56	2.19	2.86
Fair Isle	1.59[b]	1.9	2.53	3.2
Dury Voe	1.23[b]	1.54	2.17	2.84
Burra Voe (Yell Sound)	1.37[b]	1.68	2.31	2.98
Mid Yell	1.46[b]	1.77	2.40	3.07
SULLOM VOE	1.4[b]	1.71	2.34	3.01
Scalloway	1.06[c]	1.37	2.00	2.67

(b) Place	HAT (mAOD)	HAT + 0.69 m sea level rise + 0.22 m isostatic recession (mAOD)	HAT + 0.69 m sea level rise + 0.22 m isostatic recession + 0.63 m surge (mAOD)	HAT + 0.69 m sea level rise + 0.22 m isostatic recession + 1.3 m surge (mAOD)
LERWICK	1.25[a]	2.16	2.79	3.46
Fair Isle	1.59[b]	2.50	3.13	3.80
Dury Voe	1.23[b]	2.14	2.77	3.44
Burra Voe (Yell Sound)	1.37[b]	2.28	2.91	3.58
Mid Yell	1.46[b]	2.37	3.00	3.67
SULLOM VOE	1.4[b]	2.31	2.94	3.61
Scalloway	1.06[c]	1.97	2.60	3.27

[a] Estimated from the POL website (http://www.pol.ac.uk/ntslf/hilo.php?port=lerwick)
[b] Estimated using TIDECALC software
[c] Not available on TIDECALC software. Taken from Sandison (2002).

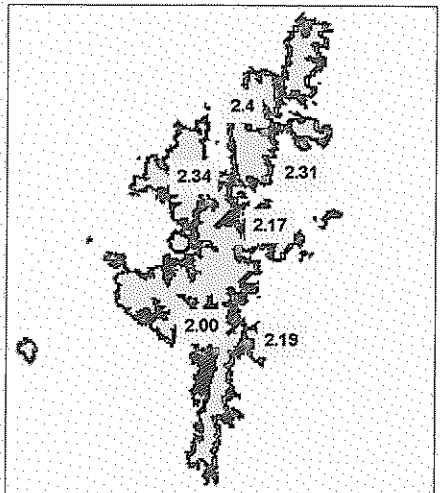


Figure 2 HAT plus 0.09 m sea level rise ("Low Emissions" Scenario) plus 0.22 m isostatic recession plus 0.63 m surge (from Lerwick tide gauge). (To mAOD Lerwick)

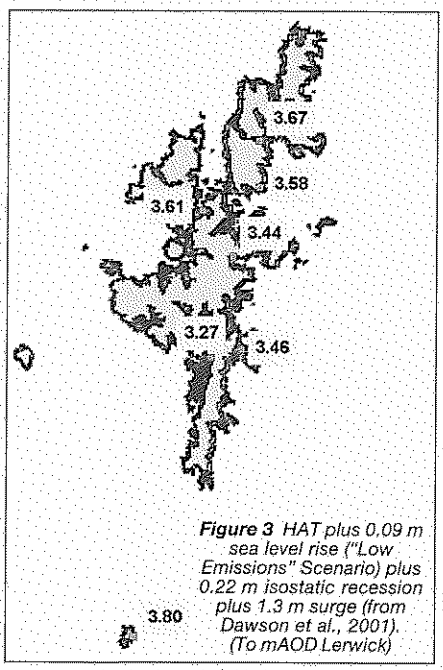


Figure 3 HAT plus 0.09 m sea level rise ("Low Emissions" Scenario) plus 0.22 m isostatic recession plus 1.3 m surge (from Dawson et al., 2001). (To mAOD Lerwick)

that the estimated future tide level is different for each port (ranging from 2.00 mAOD at Scalloway to 2.53 mAOD at Fair Isle for the "best case" scenario; 3.27 mAOD at Scalloway to 3.80 mAOD at Fair Isle for the "worst case" scenario). This is because of the different HAT associated with each port (within a given scenario, the same estimated sea level rise and storm surge being used at each port).

The highest tide level is 3.80 mAOD at Fair Isle for the "worst case" scenario (for reference, the tide level estimated for Lerwick under the "worst case" scenario is 3.46 mAOD). Even accounting for the ~0.24 m difference between the Lerwick and Newlyn Ordnance Datums (where the tide level at Fair Isle converts to approximately 4.04 mAOD Newlyn), it is interesting to note that this tide level is almost 1 m lower than the 5 mAOD Newlyn contour line identified by Werritty *et al.* (2002).

***Table 4** "Best case" ("Low Emissions Scenario", HAT + 0.09 m sea level rise + an estimated 0.22 m isostatic recession, and 0.63 m surge) and "worst case" ("High Emissions Scenario", HAT + 0.69 m sea level rise + an estimated 0.22 m isostatic recession and 1.3 m surge) scenarios.*

Place	"Best case" (mAOD)	"Worst case" (mAOD)
LERWICK	2.19	3.46
Fair Isle	2.53	3.80
Dury Voe	2.17	3.44
Burra Voe (Yell Sound	2.31	3.58
Mid Yell	2.40	3.67
SULLOM VOE	2.34	3.61
Scalloway	2.00	3.27

This suggests that, within the limitations of the approach adopted here, the 5 mAOD Newlyn contour line may not be as applicable as an indicator of potential flood risk to the Shetland Isles as it is to the Scottish mainland.

However, any development proposed at sites with elevations at or just above the flood levels estimated in this report should, as a further precaution, incorporate sufficient freeboard into their design.

The author gratefully acknowledges the assistance of SEPA, the NERC Proudman Oceanographic Laboratory, Vic Hawthorne (Shetland Isles Council) and Andy Sandison (Arch Henderson and Partners). The opinions expressed in this paper are those of the author and do not necessarily reflect the view of the Scottish Environment Protection Agency.

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Floods in Scotland

Scottish Hydrological Group joint meeting with the Scottish Centre of the Royal Meteorological Society Perth, 25 April 2003

Flooding meetings in Scotland normally generate a great deal of interest, and this one-day meeting was no exception. A capacity audience of 110 SEPA hydrologists, consultants, academics and "enthusiastic amateurs" attended to hear papers about meteorological aspects, flood hazard management, and applications of the *Flood Estimation Handbook* and its implications in Scotland.

Richard Tabony (Met Office) began by describing Scotland's experience of short-duration rainstorms. Scotland is famous for the frequency and duration of rainstorms, rather than rainfall intensity, but short-duration rainstorms have recently resulted in the inundation of numerous properties (500 in Glasgow in July 2002). The effects of global warming on rainfall were discussed, noting that rainfall levels per rainfall event are likely to increase, regardless of mitigating actions. At present, somewhere in the central belt of Scotland will experience a 1-in-1000 rainfall event, once every five years. Richard raised concern at the complex procedure of assigning a return period that may not correspond to the appropriate catchment area, timing and concentration of a rainstorm.

Clive Pierce (Met Office, Joint Centre for Hydro-Meteorological Research) outlined work undertaken by the Met Office to improve short-range predictions of precipitation at

high spatial and temporal resolutions. He gave a detailed account of the Qualitative Precipitation Nowcast (QPN) system including vertical profile corrections, raingauge mean field bias adjustment procedures, advection schemes and conceptual life cycle models of convection. Future research aims to quantify uncertainties and errors in QPNs for the end user (by investigating spatio-temporal properties and multi-scaling), moving towards probabilistic rainfall forecasting.

Marjory Roy (Former Superintendent, Met Office, Edinburgh) and **Geoffrey Monk** (Geoff Monk and Associates) discussed the "meteorological scenarios associated with long-duration floods", providing an informative overview of flood-generating weather patterns across Scotland, highlighting the different nature of 'easterly' and 'westerly' systems. Geoff noted that it was not possible to relate an individual rainfall event to climate change, and decadal patterns must be studied in order to show if rainfall distribution has been affected by global warming. Marjory described the origins of meteorological situations that have led to recent serious flooding in Scotland: prolonged orographic rainfall (Glasgow 1994 floods), prolonged rainfall exacerbated by rapid snowmelt (River Tay 1990 & 1993), slow moving mature depressions (River Lossie 2002).

Mike Cranston (SEPA) and **Malcolm Kitchen** (Met Office) described the benefits of using weather radar data for flood warning systems in Scotland. Some commentators express concern over the accuracy of radar outputs, but the strength of the system is that since 1991, the weather radar network in Scotland has provided the only observing system capable of measuring areal rainfall, and providing instantaneous measurement ideal for real-time forecasting. In England and Wales, data quality improvements have led to greater use of radar data in flood forecasting operations, but Scotland faces several particular challenges: less dense radar network coverage, unfavourable topography and more frequently varying types of precipitation. A comparison of radar accumulation predictions and gauged data (24 tipping buckets) in north-east Scotland found reasonable agreement (average absolute difference of 20mm). Regular post-event analysis is vital to the quality assurance of the data obtained and for the future development of the radar product. Mike and Malcolm suggested that, whilst there is no pressing need to include radar data in existing flood warning schemes, new schemes and catchments with short lead-times may benefit from its use.

David Faichney (SEPA) gave a detailed account of current flood warning schemes in Scotland, beginning with an excellent history of flood warning He outlined SEPA's recent achievements: the introduction of FloodLine and a national Flood Watch system, and the formation of the National Flood Warning Development Team. This team has undertaken recent feasibility studies for the Clyde, Kelvin and Aberdeenshire rivers.

David stressed the need to consider flood warning from an early stage when evaluating a new project, pointing out that unlike the Environment Agency south of the border, SEPA now normally considers new schemes only when approached by a local authority. He highlighted notable absences from flood warning schemes (the River Clyde, Fife, and North-East Scotland), and the fact that the Firth of Clyde is the only coastal area served by a flood warning scheme. It was important to implement a national approach to flood warning, to ensure a high standard of delivery and fair allocation of flood warning resources.

The morning's final paper, by **Kevin Tilford** (Atkins Water) introduced new guidelines for selecting flood forecasting models for flood warning, using Kilmarnock as an example. He gave a thorough summary of a risk assessment matrix and model selection process, noting the main selection criteria: cost, accuracy, ease of use and representation of physical processes. The flood forecasting model solution was based upon a cost-benefit analysis of the need to provide flood warning, the cost of (new) telemetry systems, flood warning targets, local requirements, and hydrological and hydraulic requirements. The number of residents affected, their ability to respond to warning, the scale and depth of flooding must all be considered. He stressed that this procedure offered a rapid appraisal of a scheme and acted only as a pre-cursor to more detailed design assessments. Flood defence is not an alternative to flood warning, and choosing an appropriate system can be complex.

After lunch, **David Price** (Babtie Group) presented a comparison of FEH and FSR reservoir design flood levels. The notable distinctions were that FEH design rainfall depths were higher (by over 50% in some cases) only in the west of Scotland; time-to-peak estimates were shorter in upland catchments, and SPR estimates were lower (catchments in the North of Scotland were least affected).

Comparisons between SAAR figures for 1941-70 and 1961-90 found no change in the west, but a decrease (often more than 10%) in the east. The study found design flood levels to be most sensitive to changes in the design rainfall, and relatively insensitive to changes in Tp(0). David emphasised that these results were generalised, and recommended site-specific studies. He advised awaiting the results of research into the 10,000-year design rainfall depths before undertaking any remedial works for any increase in risk.

The FEH does not offer new PMP estimates, but since seasonal PMP is a function of SAAR, unreliable predictions may ensue. Generalised results from this study indicate large reservoirs (design rainfall durations of the order of 1 day) in the west and particularly north-west, requiring rarer T-year design events, are most likely to have significantly raised peak flood levels.

Lisa Stewart (CEH Wallingford) reported on a current Defra/Environment Agency jointly-funded research project which aims to revitalise the rainfall-runoff method. FEH design rainfall depths have recently been adopted (to include 2500 additional events from 200 catchments) and new equations for ungauged sites have been introduced. High estimation errors and over-estimation of flood peaks in comparison to the FEH statistical method were problems with the current method. This project aims to tackle this, and the Flood Event Archive has been updated to include some events of Autumn 2000. Future developments will consider optimising individual events on a particular catchment in addition to research on design values of initial soil moisture capacity. The first phase of the project was testing on five catchments for model development, then testing on 25 catchments before the whole dataset, with March 2004 as the target for operational use.

Ian Lang (MWH) used Edinburgh, Glasgow and Fort William as examples to describe the predicted impact of climate change on Scotland's sewerage infrastructure. Predictions of 20% drier summers, wetter winters, greater rainfall intensity and increased variability between years presented future challenges such as 60% increases in rainfall depths, a 3-fold increase in flood volumes, more frequent flooding and the possibility that present storage capacities may be filled continuously. As the wholesale upscale of the sewerage system is unlikely to be cost-effective, Ian suggested that holistic risk management might be a sustainable solution, stressing that inputs to the sewerage system must be reduced.

Finally, **Jeremy Benn** (JBA Consulting) spoke about the automation of flood estimates at the catchment scale and its application to flood risk mapping. Digital catchment descriptors have transformed flood risk estimation. The on-going project to produce an Extreme Flood Outline for England & Wales, done for planning purposes, used the 2-D raster-based model JFLOW. The calculations are processor intensive, so in addition to dedicated processors, programmes have been embedded within screen savers across the JBA network to capitalise on idle processor time.

Automation provides a view of flood estimation at a different scale, highlights inconsistencies in current methods and provides for new thinking in the hydrological arena. Catchment Flood Management Plans, strategic studies and risk assessments for transport links should benefit from automated flood estimates, but Jeremy stressed that automation is not a replacement for more manual work for site-specific flood estimates, and lots of manual checking of the automated estimates is necessary.

The final part of the programme consisted of some personal views of future issues for flood hazard management in Scotland. **Iain McNab** (Glasgow City Council) noted that the Met Office, SEPA and Scottish Water had all acknowledged in their earlier presentations that climate change was coming. The issues surrounding flood management in Glasgow were increased sewer capacity, "daylighting" and upstream attenuation. Flood management in Glasgow was a regeneration issue and the flooding problem had to be viewed on a catchment scale.

Tim Jolley (SEPA) outlined positive progress in the last two years relating to flooding in Scotland: FloodLine, the proposed update of NPPG7, a COSLA working party on flooding, the *ad hoc* committee of ministers and its National Flooding Framework, progress of significant flood protection schemes and the new Water Environment & Water Services Act. Against all this activity, he ventured that the quality of hydrometric data had degraded, and suggested that attention must be directed to rainfall monitoring networks and continuous rainfall-runoff modelling methods.

David Crichton (an independent consultant) spoke from an insurers' viewpoint. The UK was unusual in providing insurance cover (though threatened by the removal of the 1961 guarantee). He praised the flood warning systems in place, but called for the introduction of Automatic Voice Messaging in Scotland, and highlighted the inability of some vulnerable groups to respond as effectively as others, calling for more work in that sphere. He ended with a plea for the use of non-structural approaches.

Andrew Black (University of Dundee) called for better-informed decision-making, supported by better flood risk mapping and heightened public awareness. Future flood management solutions needed to take a more integrated approach to managing land and water, as required by the new Act, and this would provide challenges for hydrologists and local authority planners alike.

During the questions and discussion that followed, **Alan Burdekin** (Scottish Executive Environment Group) revealed that second generation flood maps would be fully and freely available from October 2004. Since 1995 all flood defence proposals have included some form of attenuation, and he noted that managed retreat should be viewed as a tool and not a basis for flood defence. **Stephen Salter** (University of Edinburgh) raised the suggestion of cloud-seeding 'nasty-looking rainstorms' before they reached Scotland.

Dick Tabony (Met Office) pointed out that Scotland is in a favourable position, as water shortages across the globe mean that more rainfall is a positive outcome of climate change. **Duncan Reed** (DWR Consult) called for the digitisation of old hydrological records. **Alistair Cargill** (SEPA) was unsure about climate change, and suggested that recent floods may be no larger than those experienced in history.

Alan Werritty (University of Dundee) closed the meeting by drawing attention to the current Foresight project on flooding, commenting that the meeting had illustrated many distinctive aspects to flooding issues in Scotland. He thanked presenters and organisers for their contributions.

Amy Tavendale
University of Dundee

Copies are still available of the full-colour volume of extended abstracts that was presented to delegates on the day. If you would like one, please contact Mike Cranston, Hon. Secretary, SHG, c/o SEPA, 7 Whitefriar's Crescent, Perth, PH2 0PA, email michael.cranston@sepa.org.uk.

A risky business: hydrological risk and uncertainty under climate change

BHS National Meeting
School of Geographical Sciences, University of Bristol
21 May 2003

The second BHS National Meeting to be organised by the South-West Section took for its theme hydrological risk and climate change. Prof. Ian Cluckie welcomed 80 delegates and speakers and took the chair for the morning session.

The first presentation was by **Geoff Jenkins** (Hadley Centre), on "Climate change and probability predictions". He outlined the state-of-the-art in climate modelling, focusing on the sources of uncertainty present in current modelling approaches. He demonstrated probabilistic approaches, such as single model and multi-model ensembles, capable at least of beginning to quantify aspects of this uncertainty, which was present at all stages in the decision making process, from the choice of socio-economic scenario to technical choices of the parameterizations to be included in individual models.

David Viner (Climatic Research Unit, University of East Anglia) continued to explore climate model uncertainty. He described a cascade of uncertainty through the decision making process. From his experience with the UK Climate Impacts LINK project, he emphasised the need, in any impacts study, to evaluate multiple scenarios, multiple global models, multiple regional or downscaling schemes, multiple impact models and to subject them all to several independent interpretations. Use of a single realisation at each of these stages might lead to a partial view of possible future changes.

A discussion followed focusing on how this message could effectively be communicated to stakeholders and decision makers, who still often looked for a single deterministic prediction rather than probability-based evaluation or multiple possible evaluations.

This theme continued in the last presentation of the morning, "Climate change and hydrological risk" by **Nick Reynard** (Centre for Ecology and Hydrology). Nick showed how socio-economic development scenarios and climate change probabilities could be

translated into figures for hydrological risks using statistical and continuous simulation methods: the latter could potentially provide a national system for flood frequency analysis at ungauged sites. In moving from climatological to hydrological risk, one also needed to consider other factors, such as land-use change, that might have a similar magnitude impact and provide important feedback to the climate system.

Nick showed some possible next generation methods for analysing hydrological risk, including down-scaling using statistical weather generators or Regional Climate models, and probabilistic methods such as ensemble or sampling techniques. Returning to the debate over stake-holder needs, he questioned the received wisdom that most decision makers took a relatively short-term (10- to 20-year) view, suggesting that some areas, such as flood defence, they necessarily took a longer view because of the design life of the structures involved.

Keith Beven (Lancaster University) began the afternoon with a thought-provoking talk on "Prediction uncertainty, risk and decision making". He continued the discussion of continuous simulation and set this within a framework of model equifinality as a working paradigm for dealing with uncertain predictions. The continuous simulation method could take account of the "realisation effect": that even without the impacts of change the observed record is just one realisation of all possible realisations under current conditions. Therefore fitting asymptotic statistical distributions to short periods of data may have its limitations.

Flood frequency distributions derived from continuous models, after conditioning to get behavioural sets of model parameters on both hydrograph and flood peak data, were shown to have large uncertainty bounds at higher return periods. This can mean that if we evaluate uncertainties associated with predictions of the impacts of change, we may often find that prediction limits overlap. Keith raised the question, "If uncertainty bounds overlap, does this mean the predictions have no value?" — to which he answered an emphatic "No!" This was because we can still predict a change in the risk of a given outcome, albeit conditional on the assumed scenarios, and therefore decisions should be made in a risk-based framework that requires assessment of acceptable risk in relation to costs. The consequence of such an approach would be to place more responsibility on the decision-maker, but it would also confer greater credibility on the decisions made (and better protect the modeller against being wrong!).

The meeting closed with two institutional views of decision making that accounted for uncertain future climate changes. **Judith Johnston** (Guy Carpenter) covered the insurance industry perspectives. While insurance industry losses were increasing, this was mainly due to increased exposure, and not necessarily because of an increased number of extreme events. Moreover, over the short to medium term required by industry for prediction, conclusive trends in risk were not obviously distinguishable. Nevertheless, unforeseen events could lead to major changes within the industry and she quoted the example of Hurricane Andrew in the USA, which led to $20 billion of loss and significant bankruptcy, unmet claims and industry re-structuring. She concluded that the insurance industry should include climate change in its plans and that potentially it could lead to new opportunities and improved profitability.

The day concluded with "Decision-making in water resources — an institutional view", in which **Glenn Watts** and **Rob Wilby** presented the Environment Agency's view of how climate change scenarios could be included in their water resource planning. Glenn suggested that it was potentially more difficult to quantify changing risk due to climate change in water resources than in other areas of hydrology such as flood frequency analysis, because water resource systems were potentially more complex and necessarily required combining the tails of a number of frequency distributions. Rob presented a statistical downscaling approach, based on archived meteorological data from 1961 to 2000, by which high-resolution impact scenarios could be developed for vulnerable zones. In future such techniques might enhance the Agency's decision-making processes.

The popularity of this meeting and the excellent range of speakers that the South-West Section was able to attract indicate a substantial current focus on changes in hydrological risk, particularly from industry and regulatory agencies. This is exciting science, but also of great practical benefit to society and re-emphasises the key role hydrology has to play in generating sustainable development.

Paul Bates and Ian Cluckie
University of Bristol

Most of the presentations are online at http://www.ggy.bris.ac.uk/research/hydrology/circulation_report.htm

Probable maximum precipitation and extreme rainfall estimation

Joint meeting of BHS and the British Dam Society
Institution of Civil Engineers, London
16 April 2003

This meeting was organised jointly by BHS and BDS to discuss approaches to the estimation of extreme rainfall, particularly probable maximum precipitation (PMP), in relation to reservoir risk assessment. It was well attended, with an audience of about 60, and the quality of the speakers provoked a most interesting and lively discussion.

The meeting opened with a presentation by **Colin Clark** (Director, CHRS), describing some of his research on PMP and the implications of the new estimates for spillway design floods. He has examined many methods for the estimation of extreme rainfall events. All call into question the use of the FSR PMP values, with new research showing that the values should be increased by 50–60% in many parts of Britain. (There is also concern about the mismatch of the FEH 10 000-year rainfall and the FSR PMP.)

His studies of historical storm events, including the estimation of rainfall depths associated with these storms using soil hydraulic conductiv-

ity parameters, has suggested that in some cases the FSR PMP has already been exceeded. He cited the example of the 1898 flood over the Windermere catchment, which produced an estimated rainfall of 290mm, compared with an estimated FSR PMP of 280mm. If these results are applied to reservoired catchment areas, then the potential for serious and prolonged overtopping is considerable. PMP estimates are also likely to increase with increasing temperatures caused by climate change.

Chris Collier (University of Salford) then presented an outline of recent DEFRA-funded work on extreme rainfall events in the UK and their relationship to PMP. Extreme events were classified using sites with an average annual rainfall in the range 1400–2800mm, having duration less than 96 hours and return period in excess of 100 years. This produced 50 events during the 20th century, with most occurring in England; 30 were predominantly convective, 15 frontal and 5 orographic. Most occurred in the summer and early autumn, with the largest number of events concentrated from about 1930 to 1950, and a recent decline through to the 1990s.

The research concluded that the FSR underestimates PMP, particularly for events between 2 and 12 hours, as a number of historical storms have exceeded these estimates. The FEH PMP (10 000-year event) values are much larger than the observed storm totals for short durations, but approach the observations for durations between 10 and 24 hours. Therefore, for 10 to 24-hour storms the FEH may give the correct values of PMP. However, for shorter durations the FSR underestimates it and the FEH overestimates it.

In questions, **Howard Wheater** (Imperial College, London) stressed that the use of FEH PMP values was misleading, as the FEH did not consider PMPs. Chris Collier replied that he had adopted the 10 000-year event as indicative of PMP and acknowledged that even a 10 000-year event is beyond the limits ever intended for the frequency analysis.

Lisa Stewart (CEH Wallingford) then underlined this point. Although various studies have been undertaken at CEH on spatial dependence of extremes, focused rainfall growth curve extension (FORGEX) and the mapping of index variables, no new research has been undertaken on PMP. The recent FEH Volume 2 presented a new model of rainfall depth-duration-frequency for the UK, with rainfall return period estimates available for 2 to 2000 years and durations between 1 hour and 8 days. The software additionally allows design rainfall depths to be extrapolated for up to 10 000 years return periods. However, a number of recent studies have compared the FEH and FSR long return period estimates and found that the FEH depths are up to 50% greater, particularly in the western uplands and eastern England. The largest differences are found at 1 hour and for long return periods. Therefore, the validity of use of the 10 000-year estimates must be questioned. Further research into these problems is required and DEFRA have commissioned an independent review of the FEH methodology for return periods from 1000 to 10 000 years by **Sir David Cox**. The review will also consider the relationship between the FEH rainfall frequency methodology and PMP.

In the discussion after the morning presentations, there was a general feeling that, although FEH is obviously an improvement upon FSR, more fundamental research is needed examining the physics of historical events. The FEH was never meant as a solution to dam safety analysis, but there is concern over the lack of guidance given on its use. It is hoped that Sir David Cox will give recommendations for further research. However **Alan Brown** (KBR) suggested that the greatest risk of dam failure in the UK today comes from internal instability and erosion, not from floods — so where should any extra funding go? It was broadly agreed that more work on PMP was needed as well as additional investigation of statistical approaches relying on extreme extrapolations, and that there should be a move towards a more integrated risk-based approach to dam safety assessment.

After lunch Alan Brown (KBR) continued this theme. He outlined the findings of a recent DEFRA-funded project looking at an integrated risk assessment approach (see *www.defra.gov.uk/environment/water/rs/index.htm*). Since 1975, the risk of failure from internal erosion has become more important. However, the presentation concentrated on the risk of failure due to overtopping (floods). To estimate the annual probability of failure, 'critical' velocities were used to give a 'dam critical flood'. Two curves were then produced for an acceptable and unacceptable case: to be acceptable the annual probability must be no greater than 10^{-6}. The problem in dam safety is attaching a return period to the probable maximum flood (PMF). Recent research in both the US and Australia has tried to overcome this problem by assigning a return period to PMF through damage calculations or using a Monte Carlo based approach where PMF is defined as the flow exceeded 10% of the time during 10,000 simulations. For the UK we still need to produce a curve of event magnitude versus annual probability for up to 10^{-6}/annum.

Andreas Schumann (Ruhr University, Bochum) ended by describing the aftermath of the 2002 floods in Germany, and the new concept of flood risk there: the standard for dams is now based on a risk-oriented approach, which defines two hydrological loads:

(a) 1000-year flood — must be controlled with no damage;
(b) 10 000-year flood — dam structural integrity must be preserved.

In Germany, design floods were based on PMP estimations. However, during the August 2002 floods, an area of Saxony received 2 to 3.5 times its normal monthly rainfall in just 3 days (80% PMP). At 50% of reservoirs the return period of the event was more than 100 years, and at 5 the inflow values were within the range of the assumed 10 000-year flood. These were extreme hydrological conditions with runoff coefficients of up to 0.8, but dam structures were only damaged, not destroyed. Both the German standard and the need to consider exceptional design floods based on very low exceedance probabilities has been confirmed by reality.

This reality check provoked thoughtful and useful discussions. **Chris Binnie** suggested that in light of a 10 000-year flood in Germany last year, there is a need to recalculate the 10 000-year event in the UK. This is particularly pertinent given that some reservoir spillways are more sensitive to flood volume than flood peak (**David MacDonald**, Black and Veatch) and the extra problems posed by earth rather than concrete dams. However, in terms of reproducing these kinds of events, many hydrological models are unable to simulate runoff coefficients of 0.8. We need better hydrological models (Howard Wheater), better data availability and to rethink the relationship between flood peak and flood volume.

In conclusion, I feel that the meeting was well received by members of both societies and I hope that the recent move towards collaborative meetings will continue.

Hayley Fowler
University of Newcastle upon Tyne

Publications

IAHS *Hydrological Sciences Journal*

Contents of *Vol. 48 No. 3 (June 2003)*

Scientific papers

J. Bernier: *Décisions et comportement des décideurs face au risque hydrologique*

J. Alcamo, P. Döll, T. Henrichs, F. Kaspar, B. Lehner, T. Rösch & S. Siebert: *Development and testing of the WaterGAP 2 global model of water use and availability*

J. Alcamo, P. Döll, T. Henrichs, F. Kaspar, B. Lehner, T. Rösch & S. Siebert:

Global estimates of water withdrawals and availability under current and future "business-as-usual" conditions

H. K. Cigizoglu: *Estimation, forecasting and extrapolation of river flows by artificial neural networks*

Richard Chibanga, Jean Berlamont & Joos VandewalleModelling *and forecasting of hydrological variables using artificial neural networks: the Kafue River sub-basin*

Marina Campolo, Alfredo Soldati & Paolo Andreussi: *Artificial neural network approach to flood forecasting in the River Arno*

D. P. Solomatine & K. N. Dulal: *Model trees as an alternative to neural networks in rainfall–runoff modelling*

Pratap Singh & Lars Bengtsson: *Effect of warmer climate on the depletion of snow-covered area in the Satluj basin in the western Himalayan region*

Karen M. Croker, Andrew R. Young, Maxine D. Zaidman & H. Gwyn Rees: *Flow duration curve estimation in ephemeral catchments in Portugal*

Younes Fakir & Moumtaz Razack: *Hydrodynamic characterization of a Sahelian coastal aquifer using the ocean tide effect (Dridrate Aquifer, Morocco)*

Abdallah Alaoui, Peter Germann, Nicholas Jarvis & Marco Acutis: *Dual-porosity and kinematic wave approaches to assess the degree of preferential flow in an unsaturated soil*

Jean-Denis Taupin: *Interprétation paléoclimatique et paléohydrologique de l'origine des nodules carbonatés des terrasses du Niger aux environs de Niamey (Niger) au moyen des outils isotopiques et géochimiques*

Discussion

Pierre Ozer, Michel Erpicum, Gaston Demarée & Marc Vandiepenbeeck: *The Sahelian drought may have ended during the 1990s* — discussion of *"Analysis of a Sahelian annual rainfall index from 1896 to 2000; the drought continues", HSJ* **47**(4), 563-572.

Yann L'Hote, Gil Mahé & Bonaventure Somé: *The 1990s rainfall in the Sahel: the third driest decade since the beginning of the century* – reply to discussion.

Book reviews

"Forest Hydrology: An Introduction to Water and Forests" by Mingteh Chang

"Ecohydrology. Darwinian expression of vegetation form and function" by Peter S. Eagleson.

Contents of *Vol. 48 No. 4 (August 2003)*

Scientific papers

J. O. Onyando, A. H. Schumann & G. A. Schultz: *Simulation of flood hydrographs based on lumped and semi-distributed models for two tropical catchments in Kenya*

Jean-Claude Bader, Jean-Pierre Lamagat & Noël Guiguen: *Gestion du barrage de Manantali sur le fleuve Sénégal: analyse quantitative d'un conflit d'objectifs*

A. J. Adeloye, F. Lallemand & T. A. McMahon: *Regression models for within-year capacity adjustment in reservoir planning*

Xu Jiongxin: *A study of sediment delivery by floods in the lower Yellow River, China*

D. I. F. Grimes & M. Diop: *Satellite-based rainfall estimation for river flow forecasting in Africa. I: Rainfall estimates and hydrological forecasts*

M. Diop & D. I. F. Grimes: *Satellite-based rainfall estimation for river flow forecasting in Africa. II: African Easterly Waves, convection and rainfall*

Chang Shu & Donald H. Burn: *Spatial patterns of homogeneous pooling groups for flood frequency analysis*

I. F. Small, J. S. Rowan & R. W. Duck: *Long-term sediment yield in Crombie Reservoir catchment, Angus, and its regional significance within the Midland Valley of Scotland*

A. I. McKerchar & R. D. Henderson: *Shifts in flood and low-flow regimes in New Zealand due to interdecadal climate variations*

Devon M. Burr: *Hydraulic modelling of Athabasca Vallis, Mars*

Technical note

Ryszard Błażejewski & Sadzide Murat-Błażejewska: *Analytical solutions of a routing problem for storm water in a detention basin.*

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Members may use CEH Wallingford's Library by appointment to consult *HSJ* and other journals *(tel 01491 692266).*

PEDS 2003 meeting

Valencia, Spain
22-25 April 2003

The first international conference on Pumps, Electromechanical Devices and Systems (PEDS) applied to urban water management was organised by the Institute for Water Technology at the Polytechnic University of Valencia. The event was sponsored by Valencia Water Group, and supported by the International Water Association (IWA) and the International Association of Hydraulic Engineering and Research (IAHR).

Chairman **Dr Enrique Cabrera** opened proceedings by outlining the aims:

- To promote interaction between different professionals in the water industry, academic researchers, and manufacturers to overcome problems in the use of PEDS;
- To bridge the gap between research and practical application of solutions;
- To improve technical management of urban water systems, increase efficiency and promote sustainable water development.

There were 98 presentations scheduled, but unfortunately fewer were presented because some authors were unable to leave countries affected by the SARS virus. There were papers in eight areas: systems management, network analysis & modelling, water losses, planning & decision support systems, pumping stations, valves, transients, and monitoring control & regulation.

Keynote speakers included **Paul Reitner** (Executive Director, IWA) who looked at the future of urban water management with increasing demand, limited resources and greater environmental awareness. Integration between the water industry, commercial, domestic and agricultural sectors was seen as essential to achieve efficient water use. He presented a model of a supply network with one stream of high quality treated water for drinking and sanitation, the waste from which would be collected in an 'environmental lake'. Water from this stream would be used and re-used for toilet flushing, irrigation and other purposes that require only lower quality water. He concluded that significant redesign of water supply networks and rethinking of water companies' roles was needed.

It was interesting to learn about the different challenges faced in different countries: **Nils Kändler** (Tallinn Technical University, Estonia) explained that due to industrial decline in Estonia, water consumption has decreased twofold. The main challenge is therefore to efficiently increase flow velocities and pressures in pipes that are now carrying much less water than they were designed for. A method of minimising the energy consumed in pumping to increase flow and pressure was presented.

I was most interested in the water losses section. My PhD research at Leeds University with Yorkshire Water was to assess the ability of Ground-Penetrating Radar to detect leaks from water pipes. Since joining Severn Trent Water in April 2002, I have also been working on the PR04 leakage strategy, justifying the company bid for investment in leakage control to OFWAT.

Interesting papers were as follows: **Andrew Columbo** (University of

Toronto, Canada) estimated that for ~15% leakage, energy costs of pumping this additional water increased by ~30%. Metering is essential to measure and target leakage. **Cristina Verdu** (Murcia Water, Spain) explained how domestic meter error increases with age, and **Virginia Palau** (University of Valencia, Spain) evaluated meter performance, concluding that different types of meters need replacing at different intervals, and that all meters tend to under-register consumption.

My own paper reviewed results from field tests using a *pulseEKKO 100* Ground-Penetrating Radar (GPR) system at Yorkshire Water's leakage test facility at Esholt sewage works, near Bradford, West Yorkshire. GPR is a non-invasive geophysical technique that sends an electromagnetic wave into the ground. Wave propagation depends on the electrical properties of the ground, which are largely controlled by water content. Contrasts in properties cause a proportion of the wave to be reflected back to the surface, and alter wave speed. Therefore, repeated measurements (traces) along a survey line can be assembled to produce a subsurface image that maps layers (e.g. soil layers, water table, bedrock) and anomalies (e.g. buried pipes, voids, contaminant plumes).

A single study leak was mapped by neutron probe and earth resistance techniques as a ~7m x 9m area of significantly increased water content in near-surface soil. The effect of leaked water on the GPR image was to draw down reflectors to later arrival times (waves were slowed by water) and to disrupt reflectors from pipes and soil (strong reflections off saturated soil). Draw-down of the pipe reflector was used to estimate changes in water content, and the strong reflections were characterised by high trace power. These results confirmed the potential of GPR for leak detection. However, no significant difference was observed between control and leak data taken over other low magnitude leaks at the site, and problems were encountered with data interference from metal objects and cable TV over leaks in the urban environment of Leeds. The technique thus requires further development before practical implementation.

Aaron Lockwood (Leeds University) presented encouraging results from the Esholt test site and from leaks in the Thames water urban environment using an *EM38* ground conductivity meter and *Sound-Sens* acoustic loggers. The *EM38* showed leak plumes as areas of increased ground conductivity (increased water content). *Sound-Sens* loggers, conventionally set on the pipe, were used to take measurements at the surface. The resultant 2-D map of noise signal amplitude successfully indicated that an increase in noise was observed over the leak position.

Interestingly, the New Techniques Group of Severn Trent Water, of which I am a member, are currently testing this system on our network.

I received a BHS travel grant and I would like to thank BHS, Leeds University and Severn Trent Water for enabling me to attend the conference. It was a rewarding experience to present my research to an international audience, and discuss it with academics and industry professionals. The event increased my awareness of industry issues and introduced me to a number of useful international contacts.

Dr Ed O'Brien, Severn Trent Water
ed.obrien@severntrent.co.uk

One or two items have been held over to the next issue because of lack of space. Please send all new contributions by 6th October 2003.

Forthcoming events

BHS NATIONAL MEETING

Managing our aquatic environment in the 21st Century: contemporary issues of water quality

12th November 2003 at 10.00 at the Institution of Civil Engineers, Westminster, London

Quality and quantity aspects of the water cycle must come together in environmental management and water resources planning. The full programme (already sent out, but also on the BHS website) presents relevant research across all sectors. Book now. Convenors: Colin Neal & Ian Littlewood *(email cn@ceh.ac.uk).*

Diary

9th & 10th September 2003
UN International Year of Freshwater H_2O03 events at CEH Wallingford
Contact: Rob Flavin *(tel 01491 692406, fax 01491 692424, email rwf@ceh.ac.uk)*

12th September 2003
BHS National Meeting **(AGM at 13.30)**
"Flow monitoring: can we improve quality *and* reduce costs?"
Venue: ICE, London; Time: 10.00–16.30
Contact: Rod Hawnt, Hydro Logic Ltd *(tel 01885 483789, email hawnt@hydrologic.co.uk)*

12th November 2003
BHS National Meeting
Water quality — *see notice above*

3rd December 2003
Scottish Hydrological Group meeting
"Postgraduate research in hydrology and hydraulics (Scotland)"
Venue: Heriot-Watt University
Time: 18.00
Contact: Mike Cranston *(tel* 01738 627989, *fax* 01738 630997, *email michael.cranston@sepa.org.uk)*

14th January 2004
Scottish Hydrological Group joint meeting with SHSG
"Sewer Flooding in Glasgow"
Venue: Glasgow University
Time: 18.30
Contact: Mike Cranston *(see above)*

11th February 2004
Scottish Hydrological Group meeting
"Water resource strategies in Scotland"
Venue: G10 Rankine Building, Glasgow University Time: 18.30 *(tea at 18.00)*
Contact: Mike Cranston *(see above)*

10th March 2004
Scottish Hydrological Group meeting
"Indices of flooding in afforested catchments"
Venue: Edinburgh University
Time: 18.30
Contact: Mike Cranston *(see above)*

31st March 2004
BHS National Meeting
"Integrating wetland hydrology and ecology"
Venue: ICE, London Time: 10.00
Contact: Mike Acreman *(tel 01491 838800, email man@ceh.ac.uk)*

21st April 2004
Scottish Hydrological Group meeting
"Moray flood alleviation scheme"
Venue: Elgin (half-day, p.m.)
Contact: Mike Cranston *(see above)*

12th–16th July 2004
BHS International Conference on
"Hydrology: science and practice for the 21st century"
Venue: Imperial College, London
Contact: Dr Adrian Butler, Dept of Civil & Environmental Engineering, Imperial College, London SW7 2BU *(tel 0207 594 6122, email a.butler@ ic.ac.uk, website www.hydrology.org.uk/bhs2004)*

The BHS South-East Section's new programme of meetings will be sent out as a flyer with *Circulation*.

Copy deadline for *Circulation* No. 79 6th October 2003