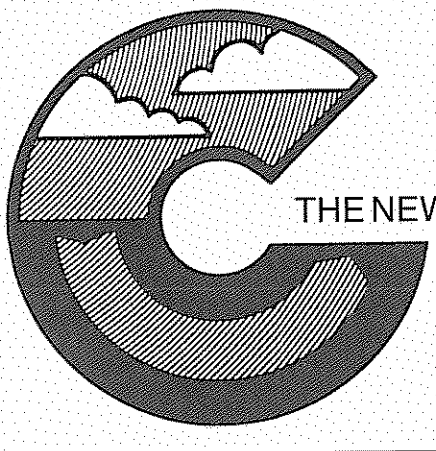
No. 83 December 2004



THE NEWSLETTER OF THE BRITISH HYDROLOGICAL SOCIETY

Circulation

Contents

BHS 21st birthday party pictures

Annual General Meeting report

Water-land-atmosphere interactions
Report of a joint meeting with the Royal Meteorological Society

Commission for Hydrology
Report of 12th CHy meeting in Geneva

The state of hydrometry overseas
James Dent reviews the past ten years

IAHS PUB decade (2003-2012)
Prediction in Ungauged Basins: gauging UK support, plus a statement from the expert meeting in Koblenz

Travel grants & Exeter Fund
Apply now to attend IAHS in Brazil

President's piece

Welcome to new members

Flood mapping and forecasting
South East Section meeting report

Advertisements
Aquator advert republished correctly; Post-doctoral fellowships at Reading

International hydrology prize
Awarded to a British hydrologist again

Low flows
Measurement, theory and practice: BHS National meeting report

Hydrometeorology in the South West: science and applications

News from members

Re-estimating flood flows for the Rivers Lossie and Findhorn

New books

Hydroecology: integration for modern regulation
New Environment Agency publication

Course: hydrology and hydraulics

Diary of forthcoming events

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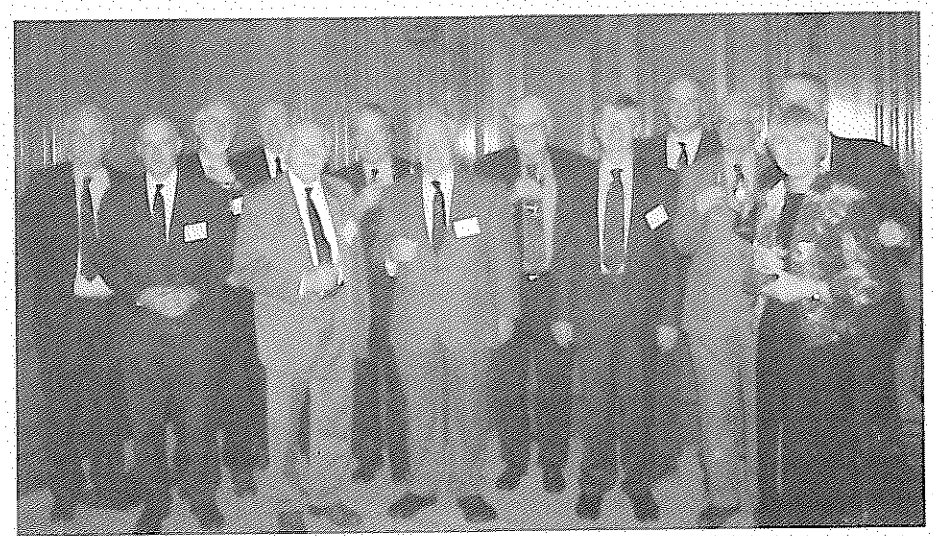
- Membership enquiries: Tim Fuller, BHS Secretary, Institution of Civil Engineers, 1-7 Great George Street, London SW1P 3AA. *Tel 0207 665 2234, Email bhs@ice.org.uk.*
- Editor: John Griffin, CEH Wallingford, *Tel 01491 692395, Email jhgr@ceh.ac.uk.*
- Web pages: **http://www.hydrology.org.uk/**

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BHS is 21!

Honorary Members and past Presidents led birthday celebrations at a full-day meeting on *"Past trends and future directions in British hydrology"* at the ICE on 10th November. A report on the presentations will be compiled for the next issue.





Past Presidents and Honorary Members toast the Society at our 21st birthday party

Thanks to Bernadette Redfern of New Civil Engineer for the use of her photographs

BHS 22nd Annual General Meeting

The 22nd Annual General Meeting of the British Hydrological Society was held during the national meeting on *Low Flows: measurement theory and practice* at the Institution of Civil Engineers in London on Wednesday 22nd September 2004.

President's report

The President, **Professor Bruce Webb** opened the meeting outlining the progress the Society has made in a number of ongoing issues. Progress was highlighted in the professional recognition for hydrologists with a non-engineering background, over which a useful dialogue has been opened with the Institution of Civil Engineers, and some candidates are being trialled through the system. He described the commercial redevelopment of the website, which is in hand with a company called Samui, and it is hoped that the new site will be able to go live this autumn. The work of the Society's committee in updating information provided to the membership in advance of the new website was described. This included the work of **Suzanne Paget** in revamping the material on Career Opportunities for Hydrologists, as part of her role as the young person's representative.

The involvement and participation of younger hydrologists in BHS had been encouraged during the year in various ways, such as through the Society's Student Awards Competition, which was held for the third time. The Society's symposium for postgraduate students involved in hydrology was hosted by Cranfield University at Silsoe in May. Through the continuing generosity of an Honorary Member of the Society, the subscriptions of a number of young members with a particular contribution to make to BHS activities have been supported.

The successful BHS International Conference '*Hydrology: Science and Practice for the 21st Century*', held from 12 to16 July 2004 at Imperial College, London, was the highlight of the programme of meetings over the last 12 months, which saw seven national and 12 regional events, including a welcome renaissance of the Welsh Section. The international conference was attended by some 300 delegates, with participants from nearly 40 countries. Approaching 140 oral papers and a substantial number of posters were presented in two sets of three parallel sessions. Written papers were pre-published in two volumes, and as a CD, while poster papers were in the process of being put on the website. A half-day programme of technical and social visits separated the sets of scientific sessions, and a rolling exhibition of hydrological equipment, software and publications was held throughout. A very interesting series of social events was also arranged to complement the scientific programme. The President thanked all concerned with the organisation of the event, especially the staff of the Environmental and Water Resource Engineering section within the Department of Civil and Environmental Engineering at Imperial College.

Bruce outlined the Society's national and international developments. Internationally, the status of the UK Committee for the IAHS was clarified as an Associate Committee, rather than a Sub-Committee of the Society. In the national context, the formation of EEON (the earth, environment and ocean network) was outlined: this is a new loose association of UK societies concerned with the earth and environmental sciences, with BHS among its founder members. The purpose of EEON was described as facilitating communication (a) between the individual societies, (b) between the societies and the government and the research councils, (c) between the societies and the media, and (d) between the societies and international science organisations. Membership of EEON was hoped to further enhance the Society's profile in government and other circles.

The President looked forward to the coming year as the Society was to reach the 21st Anniversary of its formation, which was seen as a time for celebration and reflection. The Society needs to continue to develop to meet the needs of all the hydrological constituencies in the UK, and during the coming year members will be asked via a questionnaire for their views on how best the BHS can go forward on a range of issues from publishing its own journal to changing its logo! Reaching the age of 21 is a cause for celebration, and a National Meeting was planned to mark the Anniversary in November. With the theme of 'Past Trends and Future Directions in British Hydrology' we should have a veritable galaxy of UK hydrological stars to review what progress has been made in our discipline over the past 21 years and what might be made in the next 21!

Bruce closed by expressing his appreciation to colleagues on the Main Committee and to members of ICE staff for their support over the last year. Particular thanks were given to the three members who retired from the Main Committee. **Murray Dale** was very active in organising meetings, greatly facilitated our links with the UK meteorological community and organised a splendid visit to the new Met Office headquarters in Exeter for the Main Committee. **Hilary Smithers**, who continues to maintain a link to CIWEM, played a major role as a Theme convenor at the International Conference and generally has brought her long experience of BHS matters to the Committee to very good effect. The outgoing Honorary Secretary **Andrew Black** worked exceptionally hard for the BHS in a very efficient and effective way, taking on tasks in a positive and often pro-active way, and did a great deal to ease the life of the present and previous President and to enhance the workings of the Society's Main Committee.

Hon. Secretary's and Editor's report

Andrew Black reported on the past year as the outgoing Hon. Secretary. National meetings had generally been well attended, most notably the meetings on contemporary issues of water quality and on integrating wetland hydrology and ecology. He noted however that even meetings with relative low numbers attending often resulted in very positive feedback from those attending, and he thanked all meeting organisers, speakers and reporters for their hard work. National meetings in the past year had mostly been held in London, but in the coming year they would be much more spread around the regions.

There had been much regional activity in the past year. Important developments had occurred with the holding of an inaugural meeting of the Welsh Section of BHS, which helped bring together a new committee for that Section. In the Pennines, a new Section committee had also been formed, while in other regions existing committees had continued to organise meetings and field visits on a wide range of topics.

Andrew reported on behalf of the *Circulation* Editor, **John Griffin**. Four issues of the Society's newsletter had been produced over the past year, keeping members informed of news and including meetings reports and other articles. On John's behalf, he emphasised that contributions to *Circulation* were welcome from all members, including but not restricted to meeting reports, thought-provoking discursive articles, news from members

and their employers, and photographs. He also expressed thanks to **Celia Kirby** for guest editing the August issue of *Circulation* while John was on leave from CEH Wallingford.

Finally, he wished to thank all committee members and members of the Society for their support during his time as Hon. Secretary, and expressed his own encouragement for members to be involved in the Society, as meeting organisers, national or regional committee members or in other capacities, as a means of contributing to the Society's future vitality.

Honorary Treasurer's report

Steve Parsons reported the Society's accounts for the year and gave a summary of important issues.

1. Membership
There had been a 6% increase in membership during the year with an extra 50 members registered at the end of June 2004 on last year. This followed a 4% increase during the previous year, pointing to steady real growth. At the end of June 2004 there were 900 members, although 81 were about to be removed for non-payment.

2. Summary of accounts
The accounts of the Society to be audited for the year ended 30 June 2004 in the Society's Trustees Report submission to the Charity Commission were presented. They showed a generally healthy picture, with a small operating gain on the year, a significant improvement on the budget, which was for a small net loss.

There had been a significant increase in subscription income reflecting the subscription increases. National meetings were operated at a break-even level. There was increased income from sales of adverts in *Circulation* and the web site and in sales of the Society's stock of publications. Fewer travel grants were awarded because of a smaller number of applicants, but there was increased expenditure on the website, including an initial payment made for the redevelopment of the site.

The recovery of the stock market showed a reversal of the trend of losses in the value of investments held by the Exeter Fund, which underwent an increase.

In summary, there was a net increase in total funds of around 6%. Most of the assets of the General Fund were held in high interest accounts in the Northern Rock Bank, whilst the Exeter Fund assets are invested in the Charities Official Investment Fund.

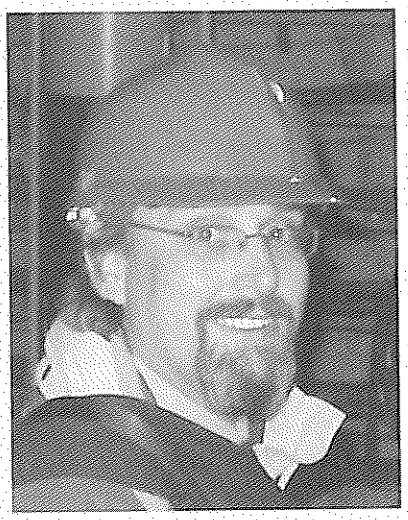
3. Financial plan for 2004/2005
The budget for 2004/2005 had been reviewed with no significant changes from expenditure in 2003/2004 expected. The major financial venture for the society in the year had been the International Conference in July 2004. Although the accounts for the event had not been finalised before the AGM, indications were that the outcome would be around break-even. In view of the healthy position at the end of 2003/2004, no increases in subscription rates for 2004/2005 were required.

Membership of Main Committee

Joe Pearce took over from Andrew Black as Honorary Secretary, **Rod Hawnt** took up the post of President Elect. Newly elected ordinary members were **Janet Makin** and **Hayley Fowler**, replacing Murray Dale and Hilary Smithers, but Hilary remains on the committee as CIWEM Representative.

New Hon. Secretary

Joe Pearce, who has taken over as Hon. Secretary from Andrew Black, has been involved in hydrology in the Environment Agency (and previously the NRA) for 14 years, and has been a member of BHS for 13 of them. He has been involved at the local level in Hampshire and Sussex in many aspects of water resources, flood defence and flood warning. He now leads the team concerned with providing hydrological data in Sussex. Joe has been active in the BHS South East Section for six years and has been on the main committee for the last three years, where he has concentrated on gaining professional recognition for hydrologists.



Joe on a visit to the Thames Barrage

Water-Land-Atmosphere Interactions

This article was submitted for the May issue. The editor apologises for the delay in publishing it.

Joint British Hydrological Society and Royal Meteorological Society meeting
Zoological Society of London Meeting Rooms
17 March 2004

It may seem surprising to the layman that the academic disciplines of hydrology and meteorology are not inextricably intermingled, but a lesson from a joint RMS and BHS discussion meeting earlier this year is that they are still disconcertingly far apart.

This joint RMS and BHS discussion meeting was attended by some 45 participants. The full presentations can be accessed from the web site *http://www.es.lancs.ac.uk/BHS_RMetS/*.

With **Chris Collier** (University of Salford), Vice-President of the RMS, in the chair, the meeting was started by **Nick Chappell** (University of Lancaster) with a talk entitled *"An introduction to coupling meteorology and hydrology"*, designed to show how research in meteorology can further hydrological research and vice-versa. Nick identified four areas where new meteorological research is assisting hydrology. First, there is value in improving understanding of meteorological processes, notably rainfall. Clearly, the spatial and temporal distributions of rainfall are the key control for river discharges, so that flood prediction will be improved by more accurate estimates of rainfall. Second, it is important to have the latest understanding of climate

dynamics (e.g. ENSO), as these changes can mask or magnify the effects of land-use changes on the hydrological system. Third, there has been a vast improvement in the availability of meteorological data for the hydrologist. The quality of both satellite and radar data have improved, whilst the use of merged precipitation data sets, e.g. the Global Precipitation Climatology Project (GPCP) data, has improved the description of the global precipitation field. The new data have provided a useful tool for evaluating GCMs and for continental scale hydrological analysis (e.g. the Global Energy and Water Cycle Experiment – GEWEX). Finally, the frequent use of GCMs is forcing hydrologists to think about the scaling issues involved with describing processes in a lumped manner, at the scale of 1° or more, rather than at the experimental catchment scale.

The hydrological research community is beginning to supply to meteorologists: (i) a new understanding of large-scale hydrological phenomena and (ii) new large-scale data, notably global riverflow, though issues remain with regard to large-scale evaporation and subsurface water data. Such data are central to the evaluation of numerical climate models. The increased collaboration between hydrologists and meteorologists has advanced research considerably, but there are still many issues to be resolved: the quality of the GCM derived water-fluxes within the tropics is far from ideal, at the regional scale, there is a lack of agreement between rainfall databases, Land Surface Schemes are over-simplified, and consequently they incorrectly generate large quantities of overland flow, there are currently no large-scale evaporation data sets, and scaling issues need further research. The following presentations addressed some of these remaining issues.

David Grimes (University of Reading) gave the first specialist talk on *Application of satellite-based rainfall estimates to river flow forecasting in Africa*. He discussed the use of satellite rainfall data to drive a river-flow forecasting model for the Bakoye catchment (Mali), where the rainfall is seasonally variable and dominated by the ITCZ, giving intense and often localised convective rainfall. There were only ever 10 raingauges available within the 100,000 km^2 Bakoye catchment, and therefore localised events were frequently missed by the gauge network.

The alternative to raingauges is to use satellite-derived rainfall data to drive the hydrological model. David's paper investigated driving the model with: (i) Infrared (IR) satellite data, (ii) IR satellite data and some extra meteorological information supplied by the European Centre for Medium-range Weather Forecasting (ECMWF) reanalysis 'data set'. Their method uses a typical IR algorithm, which relates cloud-top temperature to rainfall. This introduces errors, but they are smaller for convective rainfall than stratiform rainfall. The second method adds extra information on the storm type and the phase of the African Easterly Wave to the algorithm (though factors such as vertical wind speed and near-surface relative humidity were found to have little relationship with rainfall). A phase number was assigned to each position on the Easterly Wave (e.g. 1 for ahead of the ridge), each of which has a unique rainfall index, with higher values used to indicate higher rainfall totals. Similarly, a storm index was added for different storm types (e.g. an isolated storm or a mature squall line). When the satellite data were supplemented by the ECMWF information, the derived rainfall data then showed a significant improvement over the standard satellite based rainfall.

The rainfall derived from the two satellite methods and from the raingauge network was used to drive the 'Pitman hydrological model'. When driven by the enhanced satellite data, the fit to the observed discharges was better than when the model was forced with either the raingauge data or the satellite data alone.

Nigel Arnell (University of Southampton) addressed *Hydrological change from climate model simulations*. He stated that the predicted changes in the climate are highly uncertain, and hence their impacts on the hydrological system are even more uncertain. To assess how the hydrological cycle will respond to a changed climate regime, 'climate change scenarios' are generated in three main ways and they then form the inputs to a hydrological model by:

(i) Taking the simulated run-off from a climate model,

(ii) Using the climatic information generated by the climate model, and

(iii) Perturbing a measured rainfall time-series.

Method (i) was considered impractical because of scale and skill problems. GCMs work on a much lower resolution than a catchment-scale hydrological model and are can only correctly simulate the broad scale runoff patterns. A Regional Climate Model (RCM) has the appropriate resolution, but it is still driven by the GCM, so the detailed runoff values are wrong. Modelled rainfall has much less inter-annual variability than exists within the observational data record over southern Africa, which results in large differences at the pixel scale. Using the RCM rainfall to drive the model, and zooming in on one grid cell, shows that a very different relationship exists between discharge and return period when compared to the hydrological model driven by the observed rainfall. Thus, method (ii) must be discounted due to a skill issue. In method (iii), a climate scenario can be generated by perturbing a historical time-series: a change in absolute value, or more commonly a percentage change, can be applied.

Both perturbation methods give similar broad-scale hydrological changes but the details differ. For individual catchments, the frequency of return period generated by the two perturbation methods differs considerably. Changing the variability of a time-series is more difficult and is usually restricted to changing the relative variability, i.e. the distance of a rainfall total from the mean rainfall would change. Nigel showed that a change in climate variability could increase the frequency of large events without affecting the mean runoff. He concluded with a basic assessment of the uncertainty within the hydrological model used, but showed that the uncertainty within the hydrological model was smaller than the uncertainty due to modelled climate scenarios.

After tea, the presentations focused on how the latest land-surface information is informing meteorology. **Peter Cox** (Hadley Centre) began with a presentation on *GCM land-surface schemes: limitations and developments*. He outlined the state of the Hadley Centre Land Surface Scheme (LSS) as it was in 1997, how it has been improved and looked at future developments. In GCMs, an LSS is used to generate the lower boundary conditions for the atmosphere, with the principal tasks being:

(i) To partition the incoming rainfall from the atmospheric model into an evaporation and a runoff component and the outgoing energy flux into a sensible and a latent heat flux, and

(ii) To update the state variables that influence the energy and water fluxes, e.g. soil temperature, soil moisture content and canopy water content.

In 1997 the Hadley Centre was using the Met Office Surface Exchange Scheme 1 (MOSES 1), which contained a multi-layer soil-moisture profile and simulated the effects of plant physiology on evaporation. The vegetation model was run off-line (missing the feedback to the atmosphere from the vegetation). Further, there was no sub-grid scale variability in soil moisture or vegetation dynamics, and lateral transfers of water were not simulated.

MOSES 2 has now been developed, which has improved vegetation dynamics by closing the missing feedback loop, so that now changes in the atmosphere affect the vegetation interactively. In MOSES 1, the runoff component of the water flux was routed instantaneously to the oceans,

which failed to capture the lag that is observed in the natural system. MOSES 2 has a rooting algorithm, to give much more realistic lag times. A tiling approach is used to account for sub-grid-scale variations in land coverage in MOSES 2, with properties generated for nine surface types and applied globally. For each grid-cell, the energy and water balances are calculated separately for each land cover type within the cell and are then combined, weighting each land cover flux in proportion to its area occupied within the cell. A reduced form of TOPMODEL has been included within the new LSS to generate the proportion of the grid cells that are saturated.

A new scheme, the Joint UK Land Surface Exchange Scheme (JULES), is currently being developed by the Hadley Centre and CEH Wallingford.

Eleanor Blyth (CEH Wallingford) presented a talk on *Land-surface evaporation: how observations inform the models*. She demonstrated that there has been a large increase in the sophistication of evaporation data collection and the modelling of the evaporative process. Both fields are moving at great pace, but there needs to be greater collaboration between workers within the two fields. Currently, there is no global evaporation database, mainly because of obtaining accurate estimates from remote locations is difficult, but the aim is to produce one at the 1 km scale by generating a typical parameter set for each broad land-cover type.

Evaporation is often modelled using a SVAT model. When the SVAT models are run off-line, they are much more sensitive to parameter changes than when they are fully integrated within a climate model, because the boundary layer feedback mechanism damps the response.

Eleanor said that evaporation is highly heterogeneous, even at the smallest of scales, so that the community needs to decide whether a large-scale estimate of evaporation is a lumped measurement taken above the vegetation canopy / land-surface or whether the spatial heterogeneity is accounted for by generating an evaporation estimate for each land cover type and then summing the totals in proportion to the area occupied by that land cover.

If the lumped option is taken, there are unresolved issues over how the data can be used to update a spatially distributed model.

Mike Bonell (UNESCO) presented the final presentation, *Rainfall-runoff processes in the tropics: latest findings and links with synoptic climatology*. This focused on a much smaller scale than the preceding presentations: the hillslope, the scale at which the hydrological mechanisms within GCM Land Surface Schemes were originally identified. It also focused on the tropics, where climate changes have significant impacts on the global climate. Mike discussed tropical rainfall-runoff processes with reference to a series of example studies. In the tropics there are many more storm runoff pathways than in temperate latitudes, because tropical soils are often deeper than temperate ones. The governing parameter controlling these pathways is the saturated hydraulic conductivity (K_{sat}), which is measured at the lab scale, but it is highly heterogeneous, particularly in the vertical direction. At present, the measurements of K_{sat} provided by field hydrologists are at an inappropriate scale even for hydrological modellers, let alone climate modellers.

The maximum intensity of a tropical storm is typically an order of magnitude higher than one in the mid-latitudes. During intensive storms, particularly in cyclonic rainfall regions, surface runoff can occur. However, there still exists a large water flux into the deep subsurface, which is not present in many models. To conclude Mike stated that very local variations in rainfall pattern and intensity are critical for catchment modelling, and hydrologists would greatly benefit from meteorological information on this topic.

To summarise the meeting, the presentations have shown that the increased collaboration between hydrologists and meteorologists has advanced research considerably; however there are still many issues to be resolved. Meetings such as this are vital in promoting further collaboration and demonstrating to the two communities the ways in which they can assist each other to pursue their research within a larger integrated land-atmospheric interactions community.

This article is based on a report prepared for *Weather*, with the kind permission of the Royal Meteorological Society.

Martin Fowell, University of Lancaster

12th meeting of the Commission for Hydrology (CHy)

Geneva, 20–29 October 2004

The Commission for Hydrology, a body of the World Meteorological Organisation, meets every four years to discuss the work of the Hydrology and Water Resources Programme over the previous four years, and to decide upon the work to be done over the following four years. The WMO Hydrology and Water Resources Programme aims to promote activities in operational hydrology and to further close cooperation between national meteorological and hydrological Services worldwide.

The twelfth session of the Commission of Hydrology identified the following theme areas in which its members will work in the next inter-sessional period (2004 – 2008):

1 Basic systems (hydrometry & hydraulics),
2 Water resources assessment and water use,
3 Hydrological forecasting & prediction,
4 Disaster mitigation (floods and droughts),
5 Analysis of hydroclimatological data for variability and trends.

Cross-cutting themes were identified: capacity building and international activities (HOMS, WHYCOS, etc.).

Each of these Themes has an Advisory Working Group member assigned who contacts Experts around the world to contribute to the work in these areas.

During the meeting, **John Rodda** was awarded the prestigious IAHS International Hydrological Prize for his contribution to hydrology over many years. In particular it was noted that he had been involved in the WMO Commission for Hydrology since 1967.

CHy operates very much on the contributions of those wishing to get involved in its work. More information about the role and work of CHy and the Hydrology and Water Resources Programme of WMO can be found at *www.wmo.int*, under Programmes.

Murray Dale
Met Office

Hydrometry still in decline?

James Dent reviews "progress" over the past decade

It is now ten years since I wrote a short piece in *Circulation 44* entitled *"The Parlous State of Hydrometry Overseas"*. Without wishing to detract from the atmosphere of celebration on the 21st anniversary of BHS, I feel I have to mention this as still an area where we there has been little, if any improvement, and should be a continuing cause for concern.

In my own experience, I have come across progressive decline in hydrometeorological networks in Sri Lanka and Papua New Guinea. I am also aware that modern flood warning schemes in India, Iran and Indonesia have either failed to materialise or are already in decline because of lack of reliability in the observing networks. Add to this the collapse of services in many sub-Saharan countries, and we ought to realise how much our applications in hydrology will be based on very shaky foundations.

There are four fundamental causes of the problem:

- Lack of funding to establish new or re-establish former networks with modern equipment
- Inability of even reasonably healthy national networks to replace and upgrade worn out equipment
- Loss of funding to provide field mobility for inspection and measurement
- Lack of capacity (both human and computational) to maintain regular updating and processing of data

To redress these issues is not a trivial undertaking, but on the other hand it is not excessively expensive, and one has to speculate that the reason for the continuing existence, if not worsening, of the problem is that it is not "fashionable" to donors or recipient governments. "Sustainability" is a much-used term in development and in government in general. Funding that is aimed at "institutional strengthening" is much more readily available than anything that is purely technical. But what could be more focussed on sustainability, and beneficial to it, than a healthy hydrological and hydrometeorological database, and the strength of the government structure that supports it?

I started my hydrological career over 36 years ago, on a project funded under the International Hydrological Decade. I suggest it is time for a similar focussed effort, and that BHS should play its part, using the depth of knowledge and experience available through its members, to influence what are generally termed "the decision-makers".

James Dent (HR Wallingford)

Email network

Keep in touch with other hydrologists in Britain through the BHS electronic mailbase.

To join this free service, see the website or contact Jenny Thorne *(jthorne@south-west-water.co.uk).*

Travel grants & Exeter Fund

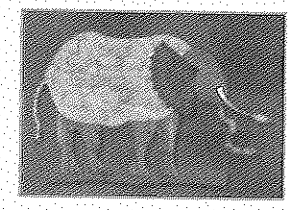
Travel grants are available to help BHS members whose travel expenses are not met by an employer to attend scientific meetings. The amount will depend on the nature and location of the meeting and the case put forward.

Grants are mainly intended to help younger members, but are open to all. Successful applicants will be expected to write a short report for *Circulation*.

The Exeter Fund offers grants to British hydrologists to take part in IAHS events, such as the forthcoming IAHS Scientific Assembly in Brazil next April. Papers will still be considered up to the end of December for some of the sessions (see *http://iahs.info*). If you are planning to go to this event, please apply quickly for assistance from the Exeter Fund, administered by BHS.

Apply to the Hon. Treasurer, **Steve Parsons**, Mott MacDonald Ltd, Demeter House, Station Road, Cambridge, CB1 2RS *(tel 01223 463926, email sbp@mm-camb.mottmac.com).*

The IAHS PUB Decade: gauging support for a UK response



Prediction in Ungauged Basins Decade (2003-2012)

BHS members who are also members of the International Association of Hydrological Sciences (IAHS: *http://iahs.info*) will be aware of the Prediction in Ungauged Basins (PUB) Decade (2003-2012). A short piece on its launch appeared in *Circulation 76* (February 2003). For further details, including the 48-page Science and Implementation Plan (where the story behind the PUB elephant is revealed), see *http://cee.uiuc.edu/research/pub/*.

Several people in the UK are already contributing to PUB through its Science Steering Group (SSG), Strategic Advisory Group (SAG), Working Groups (WGs), workshops, conference sessions and IAHS symposia (e.g. S#7 'Prediction in Ungauged Basins: Promises and Progress' at the VIIth IAHS Scientific Assembly, Foz do Iguaçu, Brazil, 3-9 April 2005). The PUB Working Group structure is developing well: see *http://www.stars.net.au/tdwg/* for details of the Top-Down modelling WG (TDWG), PUB WG1.

The Centre for Ecology and Hydrology (CEH) wishes to work with other groups and individuals towards developing a UK response to PUB. Members who are registered with the BHS electronic mailing list should have received a communication about this in October 2004. To help secure funding for a UK response to PUB (e.g. an international workshop/conference in 2006), letters of support are being sought from the UK hydrological community. Groups and individuals have been invited to respond, but it is possible that some members who might want to register their support were not contacted. Please do contact me if this is true for you or your group.

Responses so far (including an early one from BHS) have been very encouraging. However, it is important to gather as much support as possible from relevant groups, committees, research institutes, university departments and individuals. Letters of support were requested to reach me by 5th December, which may pre-date receipt of this issue of *Circulation*, so if

you do want to add your support for PUB in the UK please contact me as soon as you read this.

PUB internationally

The PUB Science and Implementation Plan describes areas of common interest with the UNESCO International Hydrological Programme (IHP) and other international programmes. A Statement from an initial meeting between representatives of PUB and UNESCO is reproduced here [see box]. The agenda and a list of participants (referred to in item 1 of the Statement) are not printed here but are available on request.

Also, please note that the Institute of Hydrology mentioned at the end of the Statement is part of the University of Freiburg in Germany (not the UK institute of our glorious past).

Ian Littlewood (igl@ceh.ac.uk)
Centre for Ecology and Hydrology
(PUB Science Steering Group)

Statement from the 1st Informal Expert Meeting between UNESCO-IHP/IAHS-PUB Koblenz, Germany, 4 - 5 May 2004

Introduction

1 The First Informal Meeting of UNESCO-IHP/IAHS-PUB Experts was held at the Institute of Hydrology in Koblenz, Germany on 4 and 5 May 2004. The agenda and the participants are listed under Annex 1 and Annex 2 respectively. *[not printed here: see Ian Littlewood]*

2 Representatives of the programmes concerned introduced the current state of development and activities of IHP-VI, FRIEND, HELP and PUB. There followed a very constructive debate on possible areas and mechanisms for co-operation. From this it became clear that there were a number of broad areas of common interest between the UNESCO programmes and PUB and, in some cases, these could be identified as specific projects on closely related technical issues.

Future co-operation

3 The meeting recognised the value of this exchange of information, but was keen to move on to a consideration of how in practice co-operative action might be encouraged so that all the programmes could benefit, while respecting their individual integrity and their need to meet their various objectives and constraints.

4 To assist in this process, it was agreed to identify areas of common interest which could be used to focus, within each group, on specific projects that might be linked in their future implementation. The initial set of these areas of interest included:
- analysis of existing data and (re-)interpretations of patterns from a process-perspective
- improved learning through the intercomparison of models in a variety of basins
- establishing collaboration between modellers and experimentalists in meso-scale basins.

5 All the programmes concerned take a bottom-up approach to the planning and implementation of their activities and so it was not appropriate, or even possible, to go into any detail on such co-operative activities until the various stakeholders concerned had been consulted in each case.

Co-operative mechanism

6 It was proposed that, in order to follow-up on the present meeting and develop concrete plans for future co-operation, a small action-oriented „Technical Liaison Group" (TLG) should be established jointly by IHP/UNESCO and PUB/IAHS to develop and review plans for co-operative action between PUB and the relevant programmes of IHP.

7 The meeting proposed that this TLG be composed of two representatives each from IHP/UNESCO and PUB/IAHS. It would meet as and when needed and agreed between the parties concerned, the first meeting being foreseen for early 2005.

8 Practical co-operative action was foreseen as being undertaken on the basis of direct links between the experts concerned.

9 The opportunity was taken to look further at the possible means of establishing links between PUB and FRIEND.

10 There are potential benefits to both the PUB and FRIEND programmes of developing co-operation in areas of common interest. It is proposed that the PUB science plan and the names of geographically relevant national and regional working group leaders are sent to each of the eight regional FRIEND co-ordinators. The FRIEND co-ordinators should be asked to circulate this information to the project leaders within each FRIEND group: They will be asked to identify FRIEND participants who:
- are working in a common scientific area
- may wish to actively work within the PUB framework.

This information will be sent by individual FRIEND project leaders to the chair of the PUB SSG who will then contact interested PUB participants and ensure that liaison will be established. In addition FIGCC will inform FRIEND participants through their web sites about opportunities to be engaged in PUB.

Close of the meeting

11 The participants expressed their appreciation to UNESCO and to the Institute of Hydrology for making convening the meeting and providing the support that made it possible.

President's piece

It hardly seems possible that a year has gone by since I was writing my first 'President's Piece' for *Circulation*, but here we are back at the start of a new session for the Society, and at a time when we welcome some new faces onto the Main Committee and say goodbye to some old ones. I would like to reiterate the thanks I expressed at the AGM to **Andrew Black**, **Murray Dale** and **Hilary Smithers** for their outstanding service to the Society as they leave the Main Committee in their capacities as Honorary Secretary and Elected Members. As sometimes happens, members who have once served the Society are generously prepared to contribute again, and it is a pleasure to report that Hilary has agreed to be co-opted back onto the Main Committee for the 2004–05 session to provide a link between CIWEM and BHS.

We also very much welcome onto the Main Committee **Rod Hawnt** (Hydro-Logic Ltd) as our President Elect. Rod has considerable experience of BHS, having served on the Main Committee and held the post of Honorary Treasurer. Equally welcome as Elected Members are **Hayley Fowler** (University of Newcastle) and **Janet Makin** (United Utilities) who come to the Main Committee with much enthusiasm and many good ideas for the Society's development. Although not new to the Main Committee, **Joe Pearce** (Environment Agency) has now been elected as Honorary Secretary and is already working hard on behalf of the Society.

Last year at this time, I was reflecting on links between BHS and the International Association of Hydrological Sciences (IAHS), and it is a very great pleasure to note that **John Rodda**, an Honorary Member of BHS, has been awarded the Association's International Hydrology Prize. The Society warmly congratulates John on winning this prestigious award.

The VIIth IAHS Scientific Assembly is being held at Foz do Iguaçu, Brazil, from 3 to 9 April 2005, and I hope it will be an attractive meeting for UK hydrologists. Please note that there are some grant monies available through the 'Exeter Fund' administered by the BHS to support attendance of UK scientists at major IAHS meetings such as this and members are encouraged to apply (please see details elsewhere in this issue of *Circulation* — page 6).

The forthcoming year is a very special one for the BHS in some ways, and this month we reach the 21st Anniversary of the Society's formation. As I write, the National Meeting arranged to both mark and to celebrate this milestone in BHS history has just taken place. The event, which was very well attended, provided a chance for a good number of the UK's leading hydrologists to review progress in the discipline in Britain and elsewhere during the past two decades, and to suggest where hydrology may go over the next twenty years. It was especially pleasing that the meeting was attended by almost all of our Past Presidents and Honorary Members, including the first President, **Mike Mansell Moullin**. In particular, the evening reception was an enjoyable opportunity for many of those involved with BHS over the years to catch up with one another and to celebrate the not inconsiderable achievements of the Society.

The 21st Anniversary seems a good time to reflect on how the Society might develop further in the future and in the coming months the membership will be asked to respond to a questionnaire about potential future initiatives, including publication of our own journal and changing our logo. The Main Committee would very much like to hear your views on these and any other ideas on how BHS can best serve its membership, so please find time, if you can, to complete and return the questionnaire when it is circulated. We are keen to seek the views of the membership not only on BHS's own development but also on wider issues within hydrology, such as those relating to the many consultations that come to BHS for a response, including the recent Environment Agency of England and Wales draft hydrology strategy, explained in the document 'Delivering Hydrology for the Environment Agency'. Invitations to send comments on consultations are sent out to members using the free BHS-HYDROLOGY email list, so please consider joining that list *(see page 6)*.

May I end by repeating what I said at this time last year, namely that I and other members of the Main Committee will always be happy to receive comments (either positive or negative) from BHS members.

Bruce W Webb
b.w.webb@exeter.ac.uk

New members

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

Peter J Campbell	Black & Veatch, Surrey
Paul Copestake	SEPA, Inverness
Amélie Deflandre	Centre for Ecology and Hydrology, Wallingford
Monica Garcia-Acebes	Environment Agency, Nottingham
Jamie Hannaford	Centre for Ecology and Hydrology, Wallingford
Graham Hill	University College, Worcester
Kim Jones	Halcrow, Swindon
Alison J Kirkpatrick	Environment Agency, Camberley, Surrey
Guy J-P Schumann	University of Dundee
Julie Stannett	Environment Agency, Exeter
Kerry J Turner	Symonds Group, East Grinstead, West Sussex
Emma Ward	Environment Agency, Flintshire
John Ward	Ayris & Ward Ltd, Rotherham

Circulation 82 Correction

Many thanks to **Celia Kirby** for editing the August issue while I was away in Europe and Asia. I had a good break and returned refreshed at the end of October. Apologies if this issue arrives later than its November date, but unfortunately there were also lots of other jobs waiting for me when I got back to work!

John Griffin

The advertisement for AQUATOR in the last issue was not reproduced in print exactly as submitted, so it is included again in this issue, in its correct layout.

Apologies to **Chris Green** of Oxford Scientific Software, who placed the advert, and also to any reader of *Circulation* who found this advert confusing or indistinct last time.

AQUATOR - The VBA Solution

Customising conjunctive use water resource models is easy in AQUATOR using *Microsoft ® Visual Basic ® for Applications.*

```
' Vary compensation flow according to reservoir state
Const fNormalCompensation As Single = 42.1!

' When state of reservoir is low gradually reduce the amount of compensation
' release (NB Resource state < 1.0 indicates state is lower than expected)

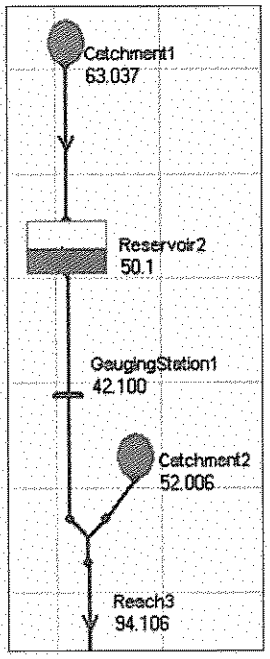
If RV2.V_ResourceState < 1! Then

  RV2.P_CompensationFlow = RV2.V_ResourceState * fNormalCompensation

Else

  RV2.P_CompensationFlow = fNormalCompensation

End If
```



- Write the most complex operating rules in *VBA* and AQUATOR integrates them into the model on a daily basis.
- *VBA* is the world's most widely used software customisation tool – as used in *Microsoft Excel* and *Word.*
- The intuitive AQUATOR interface combined with *Microsoft IntelliSense ®* makes customising AQUATOR easy for the non-specialist.

AQUATOR from Oxford Scientific Software solves the problem of simulating complex, conjunctive-use water resource systems. For more information see www.oxscisoft.com/aquator/

Latest developments in flood mapping and forecasting

BHS South East Section Meeting
ICE, London, 14 October 2004

About 50 people attended this meeting at the ICE to listen to two interesting presentations by staff of the Environment Agency. Colin Spiller discussed flood risk mapping and its application to flood warning; Gavin Sharpin and Paul Swinburn detailed the latest advances in flood forecasting.

Colin Spiller detailed the development and application of flood risk mapping, working towards an enhanced ability to target flood warnings accurately based on improved spatial definition of risk and impact within the floodplain. The Environment Agency in the Sussex area is one year into a two-year programme reviewing flood warning risk areas as part of a National programme.

Flooding is a very real risk in Sussex and has occurred within recent history, for example in Lewes, where the River Ouse catchment flooded during October 2000.

The work in the past year has looked at identifying flood risk areas (FRA) within the Indicative Flood Plain (IFP) based on certain attributes. These FRAs, when mapped, will eventually be combined to make up the Environment Agency's Flood Warning Areas (FWA), from which flood warnings are disseminated to the public and emergency services. It should be noted that the current FRAs are based on the '2003' Indicative Flood Plain and will be applied to the latest Extreme Flood Outline (EFO) map, which has recently been made available to the public on the Internet. Flood warning improvements will not be seen at the earliest until late in 2005, as flood warning generally runs a year behind flood defence.

Each identified FRA has been given a risk category. The categorisation of the risk is based on national Environment Agency guidelines. The formula takes into account the probability of flooding or return period, and the impact based on land use. This is then combined to produce a flood risk category. A combination of data sources were used to define the FRAs from the Indicative Flood Plain: Section 105 hydrological models, GIS data (such as contour data), local knowledge of defences and site visits.

Among the initial findings from the work are issues of accuracy when using the 'risk' database. Spurious data can affect the risk category and can potentially impact on future planning. Some manual adjustments have been

required, as the risk category has been created automatically by running SQL queries within ArcGIS (mapping software).

One example of such an issue was the categorisation of a school as a low risk because of a lack of data at the site. Clearly this site would constitute a high impact if it were to flood. Having identified the FRAs, the Environment Agency can use them to aid in strategic planning decisions and to enable more focused public awareness campaigns to reach high risk groups in the community.

The FRAs are derived from current best available knowledge and are continually evolving as more accurate data become available. As technologies develop and a greater appreciation of flooding is acquired, there will be a need to revisit the flood risk mapping work frequently in order to improve the flood warning system the Environment Agency provides.

Gavin Sharpin and **Paul Swinburne** gave an overview of the Southern Region Flood Forecasting System (SuRFFS) project. This project has five components: Southern Region's contribution to the National Flood Forecasting System, hydrological model development, hydrodynamic model development, the Coastal Flood Forecasting project and Rating Curve Extension Work. Gavin and Paul focused on the National Flood Forecasting System and hydrological and hydrodynamic model development.

The National Flood Forecasting System is being produced by Delft Hydraulics and Tessella for all Regions of the Agency. Southern, Midlands and North East Regions will be the first to receive it. When delivered to Southern Region under the SuRFFS project, it will be used as the single forecasting system on which all coastal and fluvial models are run.

The hydrological and hydrodynamic model development under SuRFFS will ultimately provide models to be run in real-time for the forecasting of river flooding in every catchment in Southern Region for which Flood Warning Areas exist. Currently, work has been commissioned for flood forecasting models in a few pilot catchments. An update was given on the progress made so far.

Helen Procter
Atkins Water

WATER, LIFE & CIVILISATION

POST DOCTORAL RESEARCH FELLOWS

Three-year Fixed-term, Research Grade 1A,
Initial salary in range of £21,640 (spinal point 6)

Applications are invited for three PDRA positions funded by the Leverhulme Trust as part of its Water, Life and Civilisation project being undertaken by the University of Reading. The project is researching the links between environmental change and human response in the arid Middle East/North Africa (MENA) region, with a particular focus on the Jordan Valley (see *http://www.waterlifecivilisation.org* for further details). The project is seeking three experienced researchers to be appointed as from 1 February 2005, or as soon as possible thereafter, to join an existing multi-disciplinary team which will be supplemented by further appointments during 2005 and 2006.

Palaeonvironmental reconstruction. Applicants should have a strong background in earth/environmental science or an allied subject with specialist knowledge of at least one of the following: stable and/or radiogenic isotope analysis, geomorphology of arid systems, palaeoenvironmental reconstruction. Contact: Dr Stuart Black (S.Black@reading.ac.uk)

Hydrological modelling. A numerate hydrologist is required to construct future and past hydrological regimes in the Jordan Valley. Applicants must have expertise with at least one of the following: hydrological data analysis, hydrological modelling, semi-arid/arid system hydrology, hydrometry. Contact: Professor Paul Whitehead (P.G.Whitehead@reading.ac.uk)

GIS/Spatial data processing. Applicants should have a strong background in GIS or spatial modelling in archaeology, earth/environmental science or an allied subject, a strong computational background, and experience with working with a variety of spatial data. Essential skills include knowledge of ARCH-INFO or ARC-GIS and programming skills in Visual Basic. Contact: Dr Kevin White (K.H.White@reading.ac.uk)

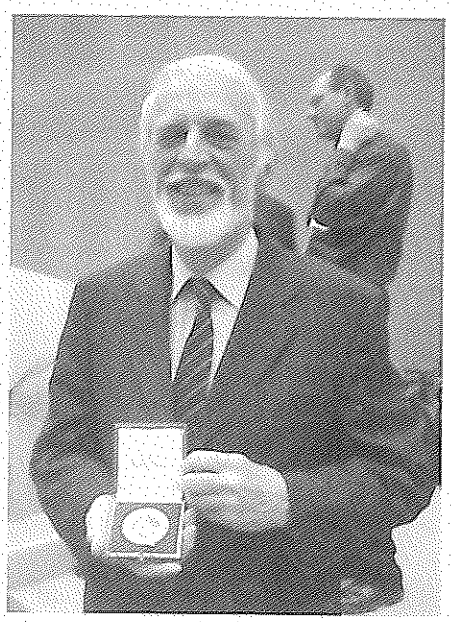
Applicants should have the ability to work within a multi-disciplinary team, be prepared to spend working periods abroad and should ideally have a current driving licence. Further details for the positions are available at http://www.waterlifecivilisation.org/vacancies/index.php

Application forms are available from the Personnel Office, The University of Reading, Whiteknights House, Reading RG66AH. Closing date Friday 17 December 2004, interviews January 14 2005.

International hydrology prizewinner

Congratulations to Honorary Member **Dr John Rodda** who has been awarded the International Hydrology Prize for 2004. John worked at the Institute of Hydrology for many years, as well as the Water Data Unit and Department of the Environment. From 1988 to 1995 he was Director of WMO's Hydrology and Water Resources Department in Geneva. John was Secretary General and then President of the International Association of Hydrological Sciences (IAHS) and has received numerous presentations over the years (including once a Russian cowbell).

John is the second British winner in succession: last year the prize went to **Dr Alan Gustard**. See *http://www.cig.ensmp.fr/~iahs/* for details.



Low flows: measurement, theory and practice

BHS national meeting, Institution of Civil Engineers, Wednesday 22 September 2004

This meeting was organised by Andy Young (Centre for Ecology and Hydrology) and Robert Grew (Environment Agency) to discuss issues related to low flow measurement, research and the use of low flows within design and regulation by UK researchers and practitioners. The outstanding need for a meeting on the subject was shown by the excellent attendance: over 100 delegates came to contribute to the discussions and listen to 13 presenters who represented a broad range of organisations from across the UK and overseas.

Following a welcome by **Andy Young**, the meeting opened with a keynote presentation by **Alan Gustard** (CEH Fellow) on *What do we mean by low flows?* This identified the operational and research priorities for low flow measurement and regulation in relation to the key attributes of low flows and the different perspectives of the groups of people who use this information.

He made a number of recommendations to help provide a common understanding. This included increasing public awareness that such conditions represent natural events, made more severe by our demands for water, and the use of web cameras on selected rivers to show the current water level, discharge and flow percentile. Alan recommended that a UK (BHS) or international (UNESCO / WMO) monograph be produced to explain the concept of discharge, flow duration curves and issues relating to low flows.

Measurement and estimation (1)

Robert Grew chaired the first session on *Measurement and Estimation*, opened by **Richard Iredale** (Environment Agency) with a presentation on *Low flow measurement: challenges and opportunities afforded by the use of new techniques and technologies*. Since measurement errors and uncertainty become more significant with reducing flow, low flow measurement is one of the most challenging areas for hydrometry practitioners. Richard presented details of ongoing Agency R&D projects that are attempting to address this issue, by studying the effectiveness of fish pass structures, and their inclusion as part of flow measurement structures. New techniques such as electro-magnetic and ultra-sonic current meters and the application of Acoustic Doppler Current Profilers (ADCPs) were being used within the Agency, and other techniques were in development, such as the use of seismic induction for flow measurement in upland turbulent streams.

Terry Marsh (CEH) gave an informed presentation on *Low flows in the UK: maximising the strategic utility of low flow data* that emphasised the interpretation of low flow data in relation to the UK's diverse climate, topography, geology and land-use patterns. A summary of the UK flow regime and measuring network followed, concluding that accurate monitoring of low flows was recognised as increasingly important, as these are most vulnerable to human or natural influences. He stressed the need to ensure that the gauging station network was capable of addressing a range of strategic UK needs, including the development of improved decision support mechanisms.

Measurement and estimation (2)

Alan Gustard chaired the second session, which began with *Drought and low flows; a European perspective* by **Lena Tallaksen** (University of Oslo). She presented methods of characterising different types of drought, with reference to the recent publication, *Tallaksen and van Lanen (2004)*[1], a new textbook aimed at university students, practising hydrologists and researchers. The accompanying CD contains data from a number of hydro-climatological regions and tools to support the understanding of process and estimation methods applicable to drought analysis.

Two recent pan-European drought initiatives were also summarised. ARIDE (Assessment of the Regional Impact of Droughts in Europe) provided a thorough understanding of the magnitude, frequency, spatial extent and seasonality of drought behaviour within Europe; ASTHyDA (Analysis, Synthesis and Transfer of knowledge and tools on Hydrological Droughts Assessment) aims to disseminate knowledge and promote collaboration within the scientific community on drought topics. This co-ordination of European activities has been continued through the formation of the European Drought Centre (EDC) in May 2004.

Further research needs identified include better monitoring and forecasting of drought, prediction of the response to climate change, and use of continuous simulation modelling to investigate the propagation of drought impacts.

Andy Young gave the final presentation of the morning on *Low flow estimation in ungauged catchments: from statistics to time series*. He conceptualised the flow estimation problem for operational water management in the form of a 3-dimensional cube, illustrating the different combinations of natural and influenced, flow statistics and time series, for gauged and ungauged catchments. He gave an overview of the functionality of Low Flows 2000, which provides estimates of natural and influenced flow statistics. The importance of providing derived natural and influenced flow time series at ungauged sites for the investigation of the ecological impacts and potential environmental change associated with water resource management was also recognised. Andy summarised the current status of collaborative research between CEH and the EA, focussing on the development of a generalised regionalised daily rainfall-runoff continuous simulation model for the estimation of river flow time series within ungauged catchments.

Morning discussion session

The discussion was chaired by Alan Gustard. **Daniel Cadman** (EA) commented that the long-term trend of increasing water deficits over large parts of the UK reported by Lena Tallaksen was not reflected in the information presented by Terry Marsh. Lena replied that this was most likely to be associated with differences in the period of record within the study and that she had referred to the period 1962–1990. **Glenis Pewsey** (South West Water) emphasised the importance of period of record in long-term trend analysis and quoted an example from South West England where an apparent increasing trend of low flows between 1962 and 1980 was removed by extending the same record back to include the 1959 drought.

Richard Maxted (EA) inquired how long it would be until simulated time series for ungauged catchments were available to operational EA users. Andy Young said that the timescale for the delivery of such models was ultimately related to the level of uncertainty that would be acceptable to the practitioner. For many ecological applications the current models would give adequate simulations, but the current research programme aimed to provide a set of models for operational implementation by the end of 2005.

Mary-Ellen Cromack (Marcus Hodges Environment Ltd) asked when a consultant's version of Low Flows 2000 would be available. Andy Young replied that some issues regarding data royalties still needed to be resolved, although *Wallingford Hydrosolutions*, a technology transfer company created by NERC in 2004, is expected to provide a web-based version of the software by the end of the financial year, and is currently offering a bureau service for flow estimates as an interim measure.

Henry Gunston (retired) asked whether, given their environmental implications, the building of concrete weir structures was still an option for flow monitoring at new sites. **Richard Iredale** (EA) replied that a current EA R&D project is looking at the feasibility of flow measurement at compound structures incorporating fish passes with weir structures; he referred to an example where flows could be measured for a larinier fish pass. **Ian Littlewood** (CEH) asked why dilution gauging was not reported as one of the potential techniques for flow gauging. Richard said that this technique is now rarely used, because of the perceived environmental impacts of adding tracers to watercourses, although it was commonly used historically and is still taught in the Agency's hydrometric training programme.

Nick Mandeville (Water Resource Associates) asked if the use of ADCPs was restricted by water turbulence. Richard Iredale commented that some problems had been experienced with surface turbulence due to aeration beneath the transducers, although ADCP's had been used successfully in rivers with a velocity exceeding 3 m s^{-1}.

David Price (Jacobs Babtie) asked if the UK low flow statistics showed any evidence of long-term trends that could be attributed to climate change. Terry Marsh said that there is little evidence of any compelling climate-driven trends. Given the natural variability in low flow patterns, he stressed the importance of historical records in providing a context against which to compare current hydrological variability.

Ben Piper (WS Atkins) asked whether, given the importance of length of record for trend analysis, and generally dry conditions throughout Europe during the 1990s, there was an effective expiry date for the standard records used by models such as Low Flows 2000, and how frequently should the record be updated? Terry Marsh commented that 1971–2000 represented the latest standard 30-year period for calculating climate statistics but ended with one of the wettest years on record in the UK. Andy Young said that the expiry date should be driven by the requirements of the user and an appreciation of sampling errors in flow statistics: what has happened in the past may not always give the best information for predicting the future.

Water resources and regulation (3)

Ben Piper chaired Session 3, which opened with a presentation by **Jennifer Taylor** (EA) on *Delivering hydrology for the Agency: implications for hydrological measurement, theory and practice*. The Environment Agency was developing a 'Hydrology Strategy' and a draft document outlining an action plan and programme for the next five years has already been produced. The strategic requirements of hydrology were summarised: the full range of hydrological assessments and variables must be included, the methods used need to be robust, with the science being established by peer review, and there has to be strict quality control of data. In addition the methods or tools used should allow for simple to complex models to be used at a number of temporal and spatial scales. These methods must also be cost-effective.

The Hydrology Strategy recognises the future needs of hydrology, which includes moving towards time series assessment, the better quantification of errors and uncertainty and moving towards integrated catchment management tools. Jennifer concluded that the Hydrology Strategy can only be delivered by encouraging partnerships and integrated working, in order that new capabilities are developed, by assessing the costs of implementation and by sharing datasets.

Richard Maxted then provided an insight into an Environment Agency R&D project with a presentation on *Developing an uncertainty estimation toolkit for naturalisation by decomposition – interim results from the Environment Agency R&D*. The main aim of the project is to develop a toolkit for naturalisation by decomposition, which allows the practitioner to assess the uncertainty introduced due to incomplete knowledge of artificial influence data. A Decision Framework, together with supporting tools, guides the user through the process of naturalisation. An example was given of the Decision Framework being used within a flow naturalisation from the Dearne Catchment in the Northeast. It was concluded that the Decision Framework gives practitioners a consistent and defensible method for completing naturalisation by decomposition, which includes an assessment of the uncertainties within the process.

Chris Kilsby (University of Newcastle) closed the session with a presentation on *Climate change, precipitation scenarios, droughts and low flows*. This talk focussed on two projects which are part of the SWURVE project completed within the Northwest of England using current climate projections within the UK. Chris presented an assessment of the quality of the climate prediction model used, HadRM3H from the Hadley Centre, followed by a summary of the two studies.

The first study applied rainfall-runoff models within 12 catchments in the Northwest, noting the changes in the water resources. The greatest impact was found within the Welsh and more Southern catchments, with decreases as much as 80% in summer months. The second study used the climate projections to assess the impact on salmon in the River Eden in Cumbria using SHETRAN. Physical habitat parameters such as discharge per unit width were used. The results suggested that, in general, there is a winter increase and summer decrease. It was concluded that there was great uncertainty within the climate change projections related to estimates of the future emissions, model parameterisation and natural climate variability, and that these uncertainties need to be recognised when the scenarios are used within hydrological studies.

Water resources and regulation (4)

With Andy Young in the chair for Session 4, **Paul Copestake** (SEPA) and **Dan Cadman** (EA) gave a joint presentation on *Hydrological assessment of the Water Framework Directive in the UK: initial characterisation and implications for further characterisation*. Paul introduced the WFD, its requirements and the time schedule for future stages. SEPA have currently completed the first stage, which includes the identification and characterisation of water bodies and the initial screening of water bodies to categorise whether these are at risk of failing to achieve good ecological status.

A draft report of the water bodies at risk within Scotland has been published (see *www.sepa.org*). The initial assessment is that there are 2400 km of water bodies, 45% of them were found to be 'At Risk', 24% of these are due to abstractions, often by hydroelectric schemes, 55% of the lochs are 'At Risk', with 37% of these due to abstraction, mainly by hydroelectric schemes.

Dan Cadman then gave a summary of the approach taken within the Environment Agency. He outlined the analysis which had been completed on a relatively broad scale using a national

database of abstractions, discharges, impoundments and other artificial influences (AI) together with the utility of Low Flows 2000 to estimate water pressure due to AI at over 6000 sites. In general the assessment has been based on the abstraction pressure, not the ecological impact and that in the future the methodology will be improved to include the geomorphology and the ecological aspects more rigorously.

Questions were then put to the floor, and **Alan Gustard** asked 'Are we doing too well?' given the previous presentation's conclusions. If we are, he conjectured, who are we doing too well for? Are we meeting the requirement of regulation; are we meeting the requirements of the public? He asked what counterparts are doing who do not have access to regionalised models such as LF2000.

Paul Copestake responded that at present all the WFD requires is that a start is made: the decision is whether it is likely to reach good status or not. At present SEPA have completed this and will now collect more information which will be required within the next stages of the WFD. Dan Cadman added that we do some things well, some badly, and perhaps we do hydrology too well in relation to other things, but that is not surprising since in the past the emphasis has been on management of water resources for regulation. He concluded that the WFD requires us to know what is causing the damage as well, and this moves away from simply regulation.

Following this discussion **Andy Gill** (WS Atkins) presented *Hands on approach to Hands Off Flows*. He focussed on the development of a rapid methodology for assessing appropriate Hands Off Flows (HOF) within a number of Cumbrian river catchments which are designated under the Habitats Directive as candidate Special Areas of Conservation (cSAC). The new approach presented uses readily available information, such as LF2000, historical flow data, EA spot gauging data and electro fishing data, together with spot flow measurements collected at different parts of the low flow regime. The methodology uses regression analyses to derive relationships between flow and the physical habitat parameters, these being based on a literature review. Comparisons with the 'discharge per metre width' analysis carried out at the University of Newcastle upon Tyne, and with EA electro fishing results, provided further confidence in the method. In conclusion it was suggested that the methodology provided a relatively low cost methodology for assessing HOF, which could be applied and adapted to any river and species.

Jane Allam (EA) asked which methods were used to measure the discharges. She was concerned that measurements were only completed at riffles at which it is often hard to get reliable estimates of discharge due to the turbulence and commented that within the EA they would normally try to complete at least six gaugings at a riffle. Andy Gill accepted that measuring discharge at riffles can be difficult. Within the study the EM (expectation - maximisation) method was used. In the regression between the discharge and the habitat factor the correlation was usually very good, and he thought that this was because they were looking at relatively small flow ranges: this might not hold true for larger flow ranges.

Richard Maxted stated that the method relies on the presumption that you know the requirement of the most susceptible species of fish and he questioned whether we are yet at the stage where we are able to estimate these requirements. Andy Gill said that they had to work with what they had, and that the LIFE research was used to derive the values. These were subsequently adjusted using expert opinion within Cumbria, since it was found that the depth and velocities in LIFE were quite high and fish were found within river reaches at depths and velocities below those quoted within LIFE.

Following the discussions, **Alistair Gill** (NPower Renewables) ended the session by speaking on the *Hydrological aspects of hydropower development in the UK*. The presentation covered the basic principal of hydroelectric schemes and focussed on the estimation of Flow Duration Curves (FDC) on which the potential energy productivity of a planned site is based. A number of methods using short-term gauged data and analogue catchments to provide long-term FDC were presented. These including regression analysis, associating the flow percentile of mean daily flow and a new method which uses the sorted flow percentile of mean daily flow. The sensitivity of the first two of these to high flow outliers, which can have a significant impact on the long-term flow duration curve, supported the use of the proposed alternative method. In conclusion, whilst theoretical and short-term gauging methods enable the prediction of flow within previously ungauged catchments, it was accepted that the methods are not always ideal for assessing the hydropower generation potential of catchments, and that new research on how to address this problem is required.

Afternoon discussion session

Rob Grew chaired the afternoon discussion. Alan Gustard asked Richard Maxted whether, in the light of current attempts to estimate the uncertainty associated with natural benchmark flows, this uncertainty would be taken into account within the EA abstraction licensing system. Richard replied that uncertainty is not explicitly included within the EA licensing procedure at present, or in the Resource Assessment and Management framework. However, any uncertainties with the estimates could be included within the licensing process through the use of time-limiting licences, which provides the opportunity to re-evaluate licence conditions in the future. Dan Cadman agreed with the general conclusion that the EA are not able to incorporate uncertainties within their standard processes at present. However, within protected areas, for example any designated site within the Habitat Directive, the EA would use a more precautionary, risk-based approach to limit the likelihood of detrimental impact.

Paul Copestake said that in Scotland the legislation that is emerging tends towards use of the precautionary principle. SEPA implement this by taking into account the sources and reliability of data used. For example, if a developer is reliant on theoretical estimates, the uncertainty, standard error, associated with the methodology would be taken into account when issuing any licence. However, where real data is used, which they would class as 'better' data, uncertainty is often not included. Whilst it is recognised that uncertainty is still associated with estimates based on real data from the target catchment, it is hoped that this provides an incentive to developers to collect data within the target catchment.

Andrew Black (University of Dundee) asked Paul Copestake whether there was a system of quality control on the hydrometric data which has been collected before a decision is made. Paul said that often SEPA are dealing with practitioners with whom they have had a long association, and in these cases SEPA is generally confident that the organisation understands and will provide the level of information required to determine hydrological issues, such as compensation flow. However, any company, especially those previously unknown to SEPA, will be told the strict requirements that apply to the provision of the hydrological data needed to assess the environmental impact of any pressure on the water body.

Paul Mason (EA), on the subject of Andy Gill's presentation, was concerned that his method was based on discharges calculated at riffles, since gauging on a riffle is not accurate when deriving discharges. Andy replied that it was generally known that it is difficult to obtain discharge estimates on a riffle, but the discharges compared quite well with gauging station data within the catchment, which implied that the method performed reasonably well.

David Cooper asked if the influence of the previous 1–2 years' flow upon juvenile salmon populations had been

considered, as this was likely to have a more significant impact than the current spot measured flow conditions used to establish the relationship with measured salmon densities. Andy stated that they were looking at abstraction and HOF for juvenile habitat suitability only, and did not consider the requirements for migration. However, the method could be repeated using different depths and velocities to take this into account. Dan Cadman commented that although spate flows may have an important influence upon adult fish migration and juvenile populations in later years, licensed abstractions have little impact upon flows of this magnitude. Abstraction licensing regulation by the EA is therefore focussed upon the habitat available under low flow conditions, when the impact of licensed abstractions is most significant.

Henry Gunston asked Alistair Gill how many new hydropower sites are expected within the next few years. Alistair replied that NPower are considering 1 to 2 sites a year for the next five years, but there were few other developers considering that number of sites and there was not a huge amount of activity in this area.

Richard Maxted said that within the Northeast Region there has been a rise in applications. From having seen none, they are now having 4 or 5 a year that consult with the EA, with perhaps 1 or 2 of them actually going ahead. Paul Copestake (SEPA) agreed that there was not extensive development of medium-scale hydropower (1 to 34 MW), but that there was massive growth, and less regulation, of pico-hydroschemes, those that produce less than 25KW. These are being proposed in burns which had not even been considered previously. He added that the Scottish Executive is currently assessing four hydroschemes.

Glenis Pewsey raised her concerns about the way time-limiting licences might be used to manage uncertainty within the licensing procedure. This could be a problem for developers with large capital investment schemes who need to recoup expenses over a long period. Paul Copestake stated that the procedure within the WFD six-year cycle would be used to manage such problems and that the WFD explicitly states that any mitigation measures should not put 'disproportionate costs' onto developers. Richard Maxted commented that it is EA policy to consider long-term economic payback when reviewing and issuing licences.

Richard Johnson (Mountain Environments) said that the WFD mentions the riparian zone and asked whether the definition of this had been agreed. Paul Copestake stated that often the bankfull level, or mean annual flood is used, but it is more complicated when looking at groundwater wetlands, and there is no regulatory guidance on this yet. Richard Maxted and Dan Cadman made the suggestion that the UK flood map, 100-year return, could provide a general definition of whether an area is definitely outside the riparian zone.

Rob Grew asked what work will follow the WFD Initial Characterisation. Dan Cadman said that further work will focus upon the hydro-ecology, and there is a current R&D project, RAPHSA, which will focus on linking ecology to flows. The use of time series and dynamic modelling, for example the work undertaken within the CERF project, will also improve the ways in which hydrology is completed in the future.

Lena Tallaksen asked Chris Kilsby whether, since current droughts appear to be reasonably well simulated in climate models, future climate change scenarios including droughts could be used confidently. Chris explained that the reported analysis used only 30-year periods of data, so information on severe droughts could not be estimated reliably; although climate models can reproduce the main features of rainfall patterns for the UK, their performance is not so good for variability and extremes. More research is needed to assess this performance and feed back into improving the models' reliability.

The session ended with Alan Gustard thanking all those who had attended and extending this thanks to Andy Young and Rob Grew for organising the event, which had been informative and had promoted many interesting discussions.

Presentations from the meeting are available on-line through the 'past meeting' section of the BHS website at *www.hydrology.org.uk*.

Tracey Goodwin (Centre for Ecology and Hydrology) & Stephen Marks (Environment Agency)

[1] Tallaksen, L.M. & van Lanen, H.A.J. (2004) (Eds) *Hydrological Drought – Processes and Estimation Methods for Streamflow and Groundwater.* Developments in Water Sciences 48, Elsevier Science, Netherlands.

Hydrometeorology in the South West: science and applications

BHS South West Section Meeting
Met Office, Exeter
20 October 2004

The severe flooding in Boscastle in August, so vividly captured in news reports with film of victims being rescued from rooftops by helicopter, certainly meant that a meeting in the South West on hydrometeorology would have to mention it. We were not disappointed: all speakers and many questioners referred to it, but there was much else besides in this well attended meeting.

John Mitchell, Chief Scientist of the Met Office, opened the meeting by welcoming everyone to their new headquarters in Exeter. In his introduction he highlighted the importance of hydrometeorology using three examples. Topically, the first was related to the recent flooding of Boscastle, for which the 12 km grid Numerical Weather Prediction (NWP) model provided little if any forecast. However a 4km model, yet to become operational, did show some indication of intense rainfall over North Cornwall, whilst an even finer 1km grid model also showed similarly good indications of severe rainfall. John concluded that improving the grid resolution of these NWPs will improve the task of forecasting these events and he reported that the plan to implement the 4km grid model has been brought forward.

The second example reminded everyone of the expected changes in future rainfall patterns being predicted by current climate change models. The pattern of increased rainfall in the

North West of the British Isles during the winter months and less rainfall in the South East during the summer months has the potential to increase winter flooding problems in the North West and water shortage/drought conditions in the South East. His third example built on this, where he stressed the important water management issues raised by the likelihood of increased rainfall intensities over the UK in summer storms. John concluded that these three examples amply demonstrated the importance of continued interest in hydrometeorology.

Paul Bates chaired the morning session, introducing as the first speaker **Hamish Hall**, from Posford Haskoning in Exeter, on the subject of *Identification of best practice in response to pluvial flooding*. This was based on work with the Met Office to investigate issues relating to pluvial flooding, which is loosely defined as that which derives from surface runoff, small watercourses and sewers, primarily, but not exclusively, in urban areas. Generally it results from intense, short duration summer storms. Hamish reminded the audience that at half of the locations which suffered in the Autumn 2000 Floods, only three properties or fewer were affected. The project aims included determining the current capability to forecast such events, identifying suitable trigger levels, identifyicating best practice in response to pluvial flooding, and developing a basic benefit-cost tool to assess events.

Six local authorities responsible for responding to pluvial flooding were partners in the project. From interviews and discussions with these partners the consensus opinion on the current situation is that warnings and their dissemination for these specific events is poor, operational response is average and the institutional arrangements (i.e. the structure of the organisations involved) is good. An improvement to the warnings currently issued has been proposed, which comprises an early standby warning, issued six hours ahead, and a follow-up two-hour advance warning. Two hours was considered to be the shortest lead-time that would allow a local authority to mobilise resources to mitigate the potential affects of flooding. Both would focus geographically on local authority areas, or parts thereof, and would include expected rainfall depths and its likelihood. Importantly, local authority staff would be expected to monitor the rainfall events via a radar visualisation system.

The next stage assessed the operational activity undertaken by each local authority in response to pluvial flooding, which varied considerably according to the structure and resources available to each authority. To assist this process some Operational Best Practice Guidelines were produced. A Flood Event Database, along similar lines to that used by the Rivers Agency in Northern Ireland, was also developed and Hamish hoped that all local authorities will eventually be persuaded to use this to maintain a record of the effects of pluvial flooding. A benefit/cost tool was also developed, allowing local authorities to prioritise their response activities according to resources available to them.

Andrew Sibley followed with *Flood forecasting and rainfall forecasting: a Met Office forecaster's perspective*. He began by summarising the tools that a forecaster has to forecast rainfall. He explained the characteristics, both positive and negative, of radar products and NWP models. He also explained how tephigrams, streamline convergence plots and orographic correction fields could be used to guide forecasters in their assessment of rainfall. Andrew ran through three recent flooding examples, highlighting some of the real difficulties experienced by forecasters as they endeavour to forecast significant rainfall events. Each example presented a variety of challenges to the weather forecaster. The Boscastle event this summer reiterated the difficulty NWP models and radar have in identifying areas where intense convection, and hence enhanced rainfall, is likely to occur.

The event in Swanage, Dorset, in September 2002 highlighted that although "Spanish Plume" events are reasonably well understood it is still very difficult to predict the magnitude of rainfall that may occur, and more importantly where it will fall. Finally the event in Conwy, North Wales, in February 2004 showed how difficult it still is for forecasters to predict the degree to which orographic factors will enhance rainfall amounts.

Andrew concluded that improvement was required in the field of radar-based forecasts to enable prediction systems to develop rainfall echoes as well as advecting them. Improvements to the radar network would also assist, for example in North Wales! Reduction in the resolution of NWP models is also required along with the development of NWP post processing tools that can pinpoint the location of heavy rainfall cells.

Moving away from a practioner's perspective, **Ian Cluckie** (Bristol University) focused on *Recent progress in radar rainfall monitoring for flood forecasting*. Under the umbrella of the Flood Risk Management Research Consortium (FRMRC), a team at Bristol University has been investigating how to utilise new artificial intelligence modelling methods to improve the quantitative measurement of rainfall using radar. Initial work has concentrated on the S-band Chilbolton radar. The thrust of the research has been to set up fuzzy logic systems that can identify the characteristics of bright band contamination of the reflected radar signal to enable the operation of improved real-time bright band correction.

Ian explained that by using vertical pointing radar and understanding the characteristics of radar reflectivity in the vertical plane his team have been able to identify different aspects of bright band contamination. Whilst the effect of the bright band is dynamic, varying with time, they have still been able to develop generalised fuzzy logic algorithms that go some way towards isolating the bright band signal and hence enabling correction procedures to be developed. The correction algorithms can be run in real-time and the next stage is to test these ideas and algorithms on the operational C-band Kent radar. Ian and his team also have plans to investigate new artificial intelligence algorithms to solve problems with ground clutter, noise effects and to undertake sensitivity analysis in hydrometeor classification. Without doubt the commissioning of the Kent radar is eagerly awaited in both the operational and research based communities.

Given the recent move of the Met Office to the south west, **Murray Dale** took the opportunity to give a summary of *Hydrometerological projects in the Met Office*. He loosely grouped projects relating to extreme event recognition, pluvial flooding, both in the UK and flood warning in Algeria, under a "flood" banner. The DEFRA-funded extreme event recognition project has involved the initiation and trial of an improved forecast service and the specification of decision support tool for flood warning duty officers that incorporates fixed catchment variables (e.g. time-to peak, channel slope), antecedent variables (e.g. antecedent rainfall and susceptibility to blockage) and real-time variables (e.g. rainfall depth, stationarity of storm and direction of storm movement).

The pluvial flooding work, part of the project referred to earlier by Hamish Hall, involved the analysis of past rainfall events that resulted in pluvial flooding with a view to determining critical rainfall thresholds that might trigger the issue of a warning. Whilst appreciating that a threshold might be expected to vary geographically, analysis of rainfall events over Birmingham, Torbay and Conwy produced averaged thresholds that ranged from 15 mm for a 15-minute duration to 42 mm for a 6-hour duration. Murray explained that the project in Algeria was initiated following a devastating flood in Algiers in November 2001 in which there were over 800 fatalities. Rainfall of the order of 200 mm in 24 hours (similar to Boscastle) fell over a heavily urbanised

and steep-sloped catchment in which a main road topped the culverted (designed to contain a 2–5 year event) river channel. Reducing the risk of the consequences of this happening again is paramount. The investigation has included detailed analysis of the event using a 4 km resolution NWP Local Area Model, assessment of the tools needed to detect and forecast a future event, development of a proposal for an effecting early warning and alert system and training of Algerian forecasters.

As well as flood-related projects, Murray reported on work to assess climate change impact on river flow and groundwater recharge and investigations into probable maximum precipitation in Kenya. He summarised interesting work undertaken for the Volta River Authority in Ghana, in which seasonal forecasting techniques were used to improve forecasts, for periods of up to six months, of inflows to Lake Volta. The method included incorporating standard seasonal rainfall predictors, such as sea surface temperatures, into a Volta basin (inflow) forecasting model. This has resulted in an increased capability in forecasting the likelihood of extreme high or low flows. Murray was keen to stress that there were good prospects that a similar approach would be successful in other part of the tropics and some "favoured" extra tropical regions for which seasonal forecasts are exhibiting some reliability. The presentation was concluded by briefly running through the concept of a Global Hydrological Model, driven by a global circulation model, incorporating Local Area Models and large scale hydrological models with a view to supporting Disaster Management activities.

The final presentation of a long morning was by **Kevin Sene** (Atkins Water) on *Fluvial and coastal warning issues in South West England*. The work was commissioned by the Environment Agency as a flood forecasting improvements feasibility study. Kevin focused on the methodology used in the study, accounting for the recent developments nationally and the number of best practice guides that have recently been published. The wide range of hydrological and tidal forecasting challenges in the South West were summarised and the method used to assess each of these depending on whether they were classified as fluvial, estuarine of coastal was briefly explained. It was interesting to note that there are more than 50 estuaries in the region with a significant flood risk, for which approaches ranging from correlation and look-up tables to hydrodynamic models could be used to aid flood forecasting. Given the length of coastline, coastal/tidal modelling was also investigated with the potential to use off-line 2-D modelling that incorporates matrices that transform forecasts of offshore waves/water levels to inshore equivalents and the potential for wave overtopping. Inundation modelling would then enable response organisations to focus their resources to areas most at risk. The work explained by Kevin was fairly "broad-brush", but other detailed investigations have been initiated on the basis of recommendations from the final report, looking at elements as wide ranging as shingle beach and reservoir risk models.

Following the delights of the Met Office canteen (sorry restaurant!), **Dragan Savic** chaired the afternoon session, in which **Oliver Pollard** provided a *Practitioner's perspective on flood warning* in the South West. He gave a brief introduction to how flood forecasting and flood warning is delivered by the Environment Agency in the South West. This was followed by a more detailed explanation of the need for operational rainfall-runoff modelling, how this is met in the South West region and the issues and problems faced by the practitioner. Oliver described the type of transfer function models operated and presented examples of assessments of their performance. It was evident that there is insufficient confidence in their performance, since forecasts from the models have never been used to trigger the issue of a flood warning. This is perhaps surprising given that the performance of the model for the River Tone at Bishops Hull indicated that the correct flood warning level was predicted for 34 of the 39 events assessed. Despite this, Oliver did present a number of valid difficulties experienced by operational rainfall-runoff models related to errors and inconsistencies in input data, primarily related to catchment rainfall estimates but also noting the importance of accurate initialisation of catchment state and good channel rating relationships. It is primarily these areas, as well as the improvement of routine model performance analysis, that Oliver recommended as key for further work.

Following Oliver's presentation, a video of the Boscastle flooding in August 2004 was shown. This had been collated by the Environment Agency, mainly from news reports. Tim Wood (Environment Agency) also took the opportunity to report on the work underway to analyse the flood with a view to assessing the significance of the flooding event correctly.

In the discussion that followed there was considerable conjecture as to the magnitude of the flood event at Boscastle. The general consensus was that the rainfall measured was well below the PMP for the area, but Tim Wood made it clear that the Environment Agency does not wish to speculate on this and are awaiting the findings of a study that they have commissioned. There was also some discussion about the resources and effort put into flood protection, with Dragan Savic reminding us that risk management is now at the heart of decision making, whereby a hard engineered solution is only one of many options. Colin Clark also raised a point about planning regulations, intimating that the Environment Agency should be more proactive in this matter. Tim Wood responded that whilst the Agency is consulted in the planning process, and provides advice, they are not the planning authority and do not make the final decision. Perhaps the last thought on the matter should be that of Terence O'Donnell who left us to ponder on the fact that the Lynmouth flooding of 1952 occurred during the night, and suggested that if the Boscastle event had occurred overnight, loss of life may have resulted.

Graham Boyce, Met Office

News from members

Chair for Sue White

Committee member **Dr Sue White** has been appointed to the Chair in Integrated Catchment Management in the Institute of Water and Environment at Cranfield University's Silsoe campus. Sue joined Cranfield just under three years ago and is leading a research group focussing on catchment scale monitoring and modelling. She has been active in the EC SedNet initiative and a number of studies with water companies, identifying possible improvements to water quality through catchment management initiatives.

AGU Langbein lecture award

Prof. Keith Beven has been selected by the Hydrology Section of the American Geophysical Union to give the Langbein Award Lecture at the Fall Meeting in San Francisco. The award is given for "lifetime contributions to the basic science of hydrology and unselfish service promoting cooperation in hydrologic research". Keith is already an AGU Fellow and was given the Horton Award (now Hydrology Award) in 1991. He hopes not to have completed his lifetime by the time of the meeting and, if that proves to be the case, the title of the lecture will be

"Robert Horton and the application of distributed hydrological models".

Member on the move

Helen Procter, Secretary of the South East Section, has moved from the Environment Agency to work for Atkins Water, based at Epsom, Surrey.

JBA merges with GBF

Jeremy Benn (Managing Director, JBA) has announced the merger of JBA Consulting, based in Skipton, with Grantham, Brundell & Farran, Consulting Engineers of Doncaster. JBA's engineering and environmental business has a staff of 110 and turnover of £5 million. They have completed a contract for the Environment Agency to produce flood risk maps of England and Wales, and are surveying flood defences in Scotland. Grantham, Brundell & Farran are environmental and land drainage consultants, founded in the early days of railways, with a turnover of £1.2 million. Their clients include Internal Drainage Boards, the mining industry and English Nature.

Re-estimating flood flows for the Rivers Lossie and Findhorn in Moray, Scotland

Introduction

Flooding continues to be an important issue in the UK. One of the fundamentals of flood estimation for any purpose (e.g. flood defence design, insurance) is the quality of the underlying hydrometric data, particularly the flow data. While there have been recent advances in flow measurement (e.g. ultrasonic gauges, acoustic Doppler profiling), many gauging stations still only monitor river stage on a continuous basis. Measurements of flow are made when the opportunity arises. A stage-discharge relationship (or rating equation) is developed using the available river flow data (which may have been collected over a period of years).

In many cases there are comparatively few gaugings of high magnitude flood flows and very few measurements of out of bank flows. For floods with stages greater than those which have been gauged, recourse is often made to log-linear extrapolation of the rating equation in order to derive a flow value. This extrapolation assumes that the hydraulics of the channel (e.g. the cross-section) do not change significantly with increasing depth. This assumption can be inappropriate for many natural river channels (e.g. significant out of bank flows could occur, which are not explicitly accounted for in the extrapolation). In such cases, the resulting flood flow estimates may be inaccurate.

In what follows, we use out of bank flow calculations and hydraulic modelling in order to explore the validity of log-linear extrapolation for the rating curves of two gauging stations in the north east of Scotland. Where appropriate, the rating equations are refined in order to incorporate any out of bank flow estimates.

Study catchments

The Lossie and Findhorn are two catchments in the north east of Scotland and both drain northwards into the Moray Firth.

The Lossie is a largely rural catchment with moorland overlying schists, gneisses and valley gravels, with some old red sandstone. There is substantial afforestation in the catchment's headwaters, with arable land in the valley bottoms, wiht a steep rainfall gradient between the hills in the catchment's headwaters and the coastal plain where Elgin, the main settlement, is located.

SEPA's main gauging station on the Lossie is at Sheriffmills, just upstream of Elgin. Here the Lossie has a catchment area of 216 km^2, an average annual rainfall (1961-90) of 830 mm, a mean flow of 2.63 m^{3}s^{-1} and a base flow index (BFI) of 0.52. Annual maximum (AMAX) and Peaks Over Threshold (POT) flood data are available for this station from 1959. The original station was closed in 1978 and a new station opened a short distance upstream. The existing rating equation parameters (used for flood flow estimation) are summarised in Table 1. The rating equation takes the form:

$$Q = C \cdot (h + a)^B \qquad (1)$$

Where Q is flow (m^{3}s^{-1}), h is river stage (m) and C, a and B are the parameters of the rating equation. The rating equations listed here are only applied to river stages greater than a specified threshold.

The Findhorn is also a rural catchment with extensive blanket peat cover. Other than a narrow agricultural coastal plain (where Forres, the main settlement, lies), the catchment has a very steep gradient and drains the Monadhliath Mountains. SEPA has a primary gauging station at Forres, where the Findhorn has a larger catchment area (781.9 km^2) and a higher 1961-90 average annual rainfall (1099 mm) than does the Lossie at Sheriffmills. It has a higher mean flow (19.23 m^{3}s^{-1}) but a lower BFI (0.40). AMAX and POT data are available for the Forres station from 1960. The existing rating equation parameters (used for flood flow estimation at Forres) are summarised in Table 2.

All the rating equations listed in Tables 1 and 2 rely upon log-linear extrapolation for the estimation of high magnitude flood flows.

Flood history and flood data

Flood histories of both catchments have been compiled by Moray Flood Alleviation and are available on the internet *(http://www.morayflooding.org/main.htm)*.

Table 1 *Existing high flow ratings for the River Lossie at Sheriffmills gauging station*

Period	Stage threshold (m)	C	a	B
1959 to 31/7/78	0.793	14.981	0.3	1.846
31/7/78 to now	1.074	15.165	0	1.604

Table 2 *Existing high flow ratings for the River Findhorn at Forres gauging station*

Period	Stage threshold (m)	C	a	B
1958 to 31/7/61	1.683	26.3854	-0.038	2.4580
1/8/61 to 11/2/62	1.683	58.6322	-0.237	1.9591
15/2/62 to 31/12/66	1.683	45.4630	-0.079	2.1197
1/1/1967 to now	1.683	39.8314	0.073	2.1276

In summary, both catchments have a long history of flooding, with perhaps the most notable event being the "Muckle Spate" of August 1829 (Lauder, 1830), which affected many of the rivers in north-east Scotland, including the Nairn, Findhorn, Lossie, Spey, Deveron, Don and Dee. The Lossie has also experienced significant flooding within more recent years, particularly in July 1997 and November 2002. The 2002 event is thought to have been the largest since the 1829 flood and both of these events caused considerable damage in Elgin.

With respect to the Findhorn, after a period of serious flooding in the 1950s (Green, 1958; note that these events occurred before the start of the gauging station record at Forres), the Findhorn has not experienced a large flood event since the one in August 1970 (Green, 1971) when flood banks were overtopped and part of the town of Forres flooded. The gauging authority at the time estimated the flow of this flood (by log-linear extrapolation along the rating curve) to be 2406 m^3s^{-1} at Forres gauging station, the largest flood flow in the UK's National River Flow Archive. Prior to the current study, SEPA calculated a new high flow rating for Forres (the fourth rating listed in Table 2). Using this rating, the flood flow for the 1970 flood at Forres is estimated as being 1113 m^3s^{-1}, and it is this estimate which has been submitted to the Hi-Flows project.

The Local Authority, Moray Council, is designing flood alleviation schemes for both rivers.

Re-estimating flood flows

Sheriffmills gauging station

As noted above, there have been two gauging stations at Sheriffmills: one operated until 1978, and one since 1978. The present-day site is about 300 m upstream of the old site.

Cross-sectional survey data were obtained for both sites. In each case, the cross-section was taken from the floodplain on the left bank, through the gauged section, and fully across the floodplain on the right bank.

Each cross-section was then split into "left overbank", "main channel" and "right overbank" sections, and Manning's equation used to estimate flow independently for each section for a variety of flood events. The estimated flows were then summed for the full cross-section. Manning's equation is:

$$Q = [\, A \,.\, R^{2/3} . S_0^{1/2} \,] \,/\, n \qquad (2)$$

Where Q is flow, A is cross-sectional area, R is the hydraulic radius (equivalent to A/wetted perimeter), S_0 is bed slope and n is Manning's roughness.

The approximate slope of the water surface elevation between the new and old sites for the November 2002 flood event (0.00197) was used as a surrogate for S_0.

The old site was considered first. For the "main channel" section, the available high flow gaugings were used to derive a Manning's n value suitable for flood flows at this location (0.043).

For the "left overbank" and "right overbank" sections, reference was made to Chow's (1959) guidelines for estimating Manning's n. A value of 0.060 was selected for the left bank (a small area of light brush and trees) and a value of 0.065 was selected for the right bank.

Using these values, a favourable comparison was made between the flood flows estimated using Manning's equation and those estimated using the rating for the old station. For example, the highest river stage recorded at the old station was 2.370 m in 1970. Using Manning's equation, the corresponding flow is estimated as being 90 m^3s^{-1}, and, using the existing rating 92 m^3s^{-1}. The old station's existing rating was therefore judged to be adequate and was retained.

Turning to the present day gauging station, the available high flow gaugings were used to select an n value of 0.046 for the "main channel". Since the old gauging station is downstream of the present day site, and the old station's rating had been accepted, it was possible to use the old station's rating and estimates of recent flood levels and flows (e.g. July 1997 and November 2002) at that site to help guide the selection of Manning's n for the out-of-bank flows at the current gauging station. A value of 0.095 was selected for the "left overbank" and a value of 0.160 for the "right overbank".

The flood flows estimated using Manning's equation were compared with those estimated using the existing rating for the present-day station. It was found that the existing rating underestimated high magnitude flood events: e.g. the November 2002 event, the largest on the station's record, is estimated as being approximately 155 m^3s^{-1} using Manning's equation, but only 126 m^3s^{-1} using the existing high flow rating. This can be attributed to the existing rating failing to take account of out of bank flows (which are much more significant at the new site than at the old).

A new rating was therefore developed using the Manning's equation estimates (Table 3) and the AMAX and POT data reprocessed using this new rating. The (water year) AMAX data are summarised in Table 4.

For reference, using single site flood frequency analysis of the reprocessed AMAX data (using a Generalised Logistic distribution fitted using L-Moments) the November 2002 flood (155 m^3s^{-1}) is estimated as having a return period of about 1 in 106 years. This estimate is not unreasonable, given that the November 2002 flood is the largest to occur on the Lossie since August 1829.

Forres gauging station

The hydraulics of the River Findhorn in the Forres area are more complex than those of the Lossie at Sheriffmills gauging station. For example, the gauging station at Forres is about 740 m downstream of the A96 road bridge, and about 400 m upstream of the Inverness-Aberdeen railway bridge. (In general, however, these bridges do not have a significant influence upon river flow at the gauging station.) In addition, the gauging station is situated on top of a flood bank. This bank overtopped during the August 1970 flood. There is also the possibility that, during high magnitude floods, the station could be bypassed by floodwater entering the floodplain some distance upstream of the gauging station (e.g. in the Mundole area, over 1 km upstream of the gauging station).

Using Manning's equation for a single cross-section in isolation was therefore deemed to be inappropriate for investigating flood flows at the gauging station. Instead, a hydraulic model (HEC-RAS) was used to simulate flood flows along a reach of the River Findhorn. The main purpose for using this model was to test the validity of the estimate of the 1970 flood flow as being 1113 m^3s^{-1}. Note that in developing this model it was necessary to assume that the underlying river stage value of 4.71 m (and its conversion to metres above ordnance datum, mAOD, a level of 14.31 mAOD) had been measured and archived correctly.

A cross-section was taken at Forres gauging station by field survey. Additional cross-sections were drawn from a LIDAR survey (previously commissioned by the Moray Council) from approximately Mundole to the railway bridge (a little downstream of the gauging station).

Because of the possibility of bypass upstream of the gauging station and the uncertainty in the actual flow processes involved (e.g. is water stored on the floodplain or does it flow back into the main channel upstream of the

Table 3 *Accepted high flow ratings for the River Lossie at Sheriffmills gauging station*

Period	Stage threshold (m)	C	a	B
1959 to 31/7/78	0.793	14.981	0.3	1.846
31/7/78 to now	1.074	14.6072	-0.055	1.7908

Table 4 Reprocessed AMAX data for the River Lossie at Sheriffmills gauging station

Date	Q (m^3s^{-1})
20-Jan-59	27
25-Aug-60	74
14-Oct-60	29
15-Aug-62	40
19-Aug-63	46
18-Aug-64	47
18-Sep-65	49
24-Jun-66	74
02-Dec-66	45
05-May-68	86
31-Oct-68	34
17-Aug-70	90
27-Nov-70	32
17-Feb-72	32
04-May-73	15
26-Dec-73	33
01-Feb-75	22
22-Jan-76	25
06-May-77	28
04-Jul-78	70
15-Nov-78	20
09-Feb-80	25
18-Nov-80	42
02-Oct-81	84
07-Oct-82	35
23-Sep-84	66
26-Oct-84	64
10-Jun-86	46
27-Mar-87	55
25-Jan-88	53
12-May-89	34
10-Mar-90	19
28-Oct-90	66
04-Nov-91	14
15-May-93	37
06-Oct-93	64
12-Sep-95	74
27-Nov-95	13
02-Jul-97	106
13-Jul-98	36
06-Jun-99	53
26-Apr-00	84
08-Nov-00	59
30-Jul-02	53
16-Nov-02	155

A96 bridge?), two unsteady flow models were developed. The first used cross-sectional data from just downstream of the A96 road bridge to just upstream of the railway bridge. This model therefore assumed that this reach would not be bypassed upstream. The second also extended to just upstream of the railway bridge but had a start point at Mundole (some distance upstream of the A96 road bridge). The second model therefore allowed for the possibility of the loss of some flow between Mundole and the reach downstream of the A96 road bridge.

Both models adopted an unsteady flow approach. The flood banks were modelled as a series of broad-crested weirs. Following CIRIA (1993) a weir coefficient of 1.7 was adopted. For reference, the flood bank has a level of approximately 14.00 mAOD at the gauging station. A water surface slope of 0.00137 was estimated through the gauging station reach.

At each cross-section HEC-RAS uses Manning's equation to estimate flows. Each cross-section is divided into "left overbank", "main channel" and "right overbank" sub-sections, flows are calculated for each sub-section and then summed. Following analysis of the available high flow gaugings, and calibration to a small in-bank event which occurred in February 2004 (peak flow 268 m^3s^{-1}), the "main channel" n was set at 0.023.

Estimation of the out-of-bank n values was more complicated. As noted above, the main purpose of developing the HEC-RAS models was to test the validity of the existing estimate for the August 1970 flood flow. However, there are comparatively few other events within the January 1967 to present-day period (i.e. the period of the fourth existing rating in Table 2) which have significant out of bank flows. Of those, the largest (662 m^3s^{-1}) was in November 2000. Since this event occurred in the late autumn, it was assumed that the n value for the out-of-bank flows would be different from that required for the adequate simulation of summer floods (the banks of the Findhorn are wooded and have significant brush in summer). During summer, the banks of the current Sheriffmills site have a similar vegetation cover to those of the Findhorn at Forres. Reference was therefore made to the n values used at Sheriffmills and a value of 0.16 adopted for both banks at Forres.

Both models were run using the August 1970 flood hydrograph (with the estimated peak flow of 1113 m^3s^{-1}) as an upstream boundary condition, with normal depth used as a downstream boundary condition. Peak levels of 14.13 mAOD (for the Mundole to railway bridge model) and 14.16 mAOD (for the A96 to railway bridge model) were simulated at the gauging station (the observed peak level was 14.31 mAOD at the gauging station). The lower level in the Mundole model occurs because of some overtopping upstream of the A96.

Given the uncertainties associated with the modelling process (which include the cross-sectional data, estimation of Manning's n, the modelling of the flood banks, and the assumption that the underlying river level data are correct) the results appear to be acceptable. The existing rating (including the 1113 m^3s^{-1} flow estimate for the August 1970 flood) for Forres was therefore retained.

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David Cameron (SEPA, Dingwall, david.cameron@sepa.org.uk)
Ron Murdoch (SEPA, Elgin)
Derek Fraser (SEPA, Aberdeen)

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New books

IAHS Special Publication

Hydrology: a question of balance is IAHS Special Publication (blue book) No. 7. Written by John Sutcliffe, it is described as a unique hydrology text, which brings hydrological analysis to life by means of practical examples in which the author has been involved over a long career in many different parts of the world. It costs £30 and is available from Mrs Jill Gash at IAHS Press, CEH Wallingford, *tel 01491 692442, fax 692448, email jilly@iahs.demon.co.uk.*

New book on drought

Hydrological Drought — Processes and Estimation Methods for Groundwater and Streamflow, edited by Lena Tallaksen (Det of Geosciences, University of Oslo) and Henny van Lanen (Centre for Water and Climate, Wageningen University) is No. 48 in Elsevier's series *Development in Water Sciences*, published in November 2004.

It aims to provide the reader with a comprehensive review of processes and estimation methods for streamflow and groundwater drought, demonstrated using sample data sets and tools on the accompanying CD. The price is USD/Euro 175 (hardcover), USD/Euro 85 (paperback).

For more information see the website: *http://www.elsevier.com/locate/series/dws* — also the meeting report on page 11.

Hydroecology: integration for modern regulation

Hydroecological considerations are essential in balancing the water needs of society and those of the environment. All the signs are that pressure on our water resources will intensify due to climate change, new housing development and increased demand.

Good progress has been made over recent years in improving our understanding of the water requirements of riverine ecology and wetlands. Many of these developments and their application have been presented at BHS meetings on hydroecology. The Environment Agency has recently published *Hydroecology: Integration for modern regulation*, setting out our strategy for the development of hydroecology in support of our regulatory work.

The publication *Hydroecology: integration for modern regulation* presents a clear way forward in terms of hydroecology and its application. It can be accessed from the Environment Agency water resources web site at *http://www.environment-agency.gov.uk/subjects/waterres/879160/*.

If you would like any further information, please contact **Doug Wilson** at the Environment Agency: *doug.wilson@environment-agency.gov.uk*.

BHS: the next 21 years

Following the success of the meeting marking BHS's 21st birthday, we thought that it would be good to let the next generation of hydrologists have a say. We have offered to host a meeting at Lancaster in 2005 on *"British Hydrology: the Next 21 Years"*, where the speakers should all be under, say, 35 or still quite early in their research career.

Please give us any suggestions of format or offers of speakers who are beginning to lead their fields and who will be stimulating in their views of the next 21 years for any of the activities covered by BHS. This will be an interesting period for hydrological research, practice and policy, and we hope this meeting might address some of the critical issues as well as leaving plenty of time for discussion.

The date (early in 2005) has yet to be agreed to fit into the BHS timetable.

Louise Heathwaite (louise.heathwaite@lancaster.ac.uk), Keith Beven (k.beven@lancaster.ac.uk)

Diary

15th December 2004
BHS Midlands Section meeting
"Saving the Severn"
Venue: Aston Webb Building, Birmingham University
Contact: Dr Chris Bradley, University of Birmingham *(tel 0121 414 8097, fax 0121 414 5528, email c.bradley@bham.ac.uk)*

19th January 2005
BHS National meeting
"Flood estimation: advances in data and methods"
Venue: Institution of Civil Engineers, 1 Great George St, London SW1P 3AA
Time: 10.30–16.50
Contact: Peter Ede, Mott MacDonald *(email peter.ede@mottmac.com)*

19th January 2005
SHG/SHSG joint meeting
"Floodplain mapping in Scotland"
Venue: Rankine Building, University of Glasgow, Time: 18.30 (tea at 18.00)
Contact: Mike Cranston *(tel 01738 627989, fax 01738 630997, email michael.cranston@sepa.org.uk)*

20th January 2005
BHS South East Section meeting
"Quality Assurance in model-based catchment and river basin management"
Venue: ICE, London
Time: 18.00
Contact: Helen Procter *(tel 01372 754201, email helen.procter@atkinsglobal.com)*

3rd–9th April 2005
7th IAHS Scientific Assembly
Venue: Foz do Iguaçu, Brazil
See the IAHS website: *http://iahs.info*

24th–29th April 2005
European Geosciences Union General Assembly 2005
Venue: Vienna, Austria
Contact: *http://www.copernicus.org/EGU/ga/egu05/index.htm*

Copy deadline for *Circulation* No. 84 9th January 2004

HR Wallingford

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22 – 24 February and 1 – 3 March 2005

at HR Wallingford Ltd, Wallingford, Oxfordshire, United Kingdom

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Some background knowledge in hydrology or hydraulics would be helpful, or education to degree level in geography, civil engineering or environmental science.

COURSE CONTENT

The course will cover the following elements:

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- Estimating flows and flow hydrographs
- River flow processes
- Channel conveyance
- Flow resistance and roughness
- Behaviour and modelling of river structures
- Development and flood risk

DETAILS

The course will be held at HR Wallingford in Oxfordshire, mid-way between Reading and Oxford. The 36 hectare science park site is bounded by the River Thames, and has purpose-built training facilities providing the ideal setting for the event.

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