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Circulation

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Flood Estimation Handbook Forum

CEH Wallingford
13 November 2001

The first *Flood Estimation Handbook Forum*, held by the Centre for Ecology & Hydrology at Wallingford, was an opportunity for users to share their experiences in using the Handbook and its associated software. *Professor Jim Wallace* (Director of Hydrology, CEH) opened the meeting by welcoming over 70 people, from the environmental agencies, consultants, universities, local authorities and the FEH research team, to this first national user meeting since the FEH was launched at the end of 1999.

In each of three sessions, brief presentations were followed by discussion. The topics chosen for Sessions 1 and 2 were those most commonly raised by users in questionnaires completed before the meeting. Session 3 included announcements about new research and details of an application of FEH procedures.

Session 1 — Flood peak data

With **Con Cunnane** (National University of Ireland) in the chair, **Jack Mason** (Lewin, Fryer & Partners) presented *"Some highs and lows in flood peak estimation"*, emphasising the importance of good annual maximum flood peak data to flood frequency estimation. Spot gaugings carried out at high flows to check existing rating curves often show the existing high flow rating to be badly defined. This has implications for estimating the median annual flood (QMED) and deriving growth curves. In raising points for discussion, he wondered whether flood peak records could be graded according to quality, and if the gauging authorities could offer a point

In the Circulation **PLUS** *section:*

A source of bias in regionalisation equations — Ian Littlewood, CEH
International water conference: from Dublin to Bonn — John Rodda

of contact to discuss issues relating to their flood peak data records.

Peter Spencer (Environment Agency) in *"Updating and dissemination of flood peak data"* noted that the three UK gauging authorities now held flood peak flows that were significantly different from those used in the FEH. In many cases updates to the annual maximum records used were now available. The Agency has successfully led a bid to the government's Capital Modernisation Fund for funding to create a single authoritative UK high flow dataset. Data will be available over the Internet with a user-friendly interface to help FEH users obtain the data they need.

Summary of discussion

Discrepancies between FEH and EA data
There are marked differences between some of the flood peak data supplied in the FEH data set and data held by the Agency. These might be explained by the fact that data have largely been derived independently: e.g. the FEH dataset derived at CEH Wallingford mainly comprises instantaneous flood peaks; data held by the EA is likely to be based on 15-minute data. Marked differences are probably explained by the use of different rating curves.

New project
High flow data will be updated and disseminated in a project funded by the Capital Modernisation Fund running from October 2001 to September 2003. The objective is to produce a definitive high flow dataset. It is publicly funded and so data access will not be limited.

As an interim solution, recent annual maximum data will be added to FEH records as part of the Catchment Flood Management Plans work. Inconsistencies with the current FEH dataset are to be avoided.

Poor quality of flood peak data
Up to 80% of high flow ratings may be unreliable, at least in some parts of the country, with obvious implications for the use of donors/analogues. One likely reason is that a number of gauges were originally conceived as low-flow gauges (in the 1960s) and later 'pressed into use' for flood estimation.

Additional information about data
It was suggested that users would profit from additional information about the data, such as rating curves, highest current meter measurement and possibly quality grading of data.

Additional information about gauges
The pooling-group approach in the statistical method means that users will need information about sites all over the UK. It was suggested that a user group could exchange the information.

Updating records – contacts at gauging authorities
It was suggested that a list of contacts, to act as a starting point, would make it easier for users to get the necessary information for updating records.

Collecting field data
It was repeatedly pointed out that field measurements are essential, especially of high flows. However, since that put a strain on resources, the measurements were often not done.

Use of Peaks-over-threshold series
If a water year contains two severe flood events, as seen in many places in 2000, it is desirable to include both events in flood frequency analysis. Whereas the peaks-over-threshold time series (POT) would contain both events, only the larger event would be chosen for the annual maximum (AM) series. The FEH does not describe methods for flood frequency analyses of POT series. A prerequisite for a possible extension of the available AM methods to POT is that currently available POT series are updated and new series added.

There are applications requiring estimates of very frequent events, say a flood that occurs on average six times a year. Analysis might be based on POT series if the abstraction threshold delivers sufficient number of POT events to make estimates valid.

Flood volumes
The autumn 2000 floods were outstanding, not so much because of their peak flows, but because of the duration over which high flows were sustained (and their widespread nature). These events showed that thought should also be given to developing methods for flood volume analysis.

Use of rainfall data
It was suggested that rainfall data could be used to validate and extend flood records, since rainfall records are typically longer.

Exporting catchment boundaries from the FEH CD-ROM
Users would find it very useful to be able to export catchment boundaries from the FEH CD-ROM to import them into GIS software, e.g. ARCVIEW. In the current version this is not possible. This is not an omission: it was dictated by licensing agreements. The matter will be looked into for any future release of the FEH CD-ROM.

This summary by the FEH Forum organisers describes the presentations briefly and records some of the key issues raised during discussion. Many of the presentations can be viewed on the FEH web site at **www.nwl.ac.uk/feh/fehforum.htm**. The content does not necessarily reflect the opinions of the FEH Team or CEH Wallingford.

Session 2 — Procedures for flood frequency estimation

Statistical method

David MacDonald (Binnie, Black & Veatch) chaired this part, which began with "Selecting and adapting pooling-groups" by Peter Walsh (BHS President, Bullen Consultants). The use of pooling-groups is an essential part of the FEH statistical method. The analyst has greater opportunity to use his/her experience in producing flood growth curves than when using FSR regional curves. The software that generates the pooling-group (WINFAP-FEH) also allows the user to modify the group and the annual maximum data used. Peter described situations where the selection and adaptation of pooling groups is far from straightforward.

"Appraisal of the FEH procedures" by **Dave Morris** (CEH Wallingford) described recent investigations into the performance of the FEH statistical method. The method has been automated and applied at 50 m intervals throughout several large river networks. To achieve spatially consistent results it had been necessary to use multiple donor/analogue gauges with gradually varying weights and to avoid using small pooling-groups. The results showed that users should be wary of inconsistent flood estimates in some locations, particularly at confluences of catchments of dissimilar soil types. Dave concluded with some recommendations for developing the method.

Summary of discussion

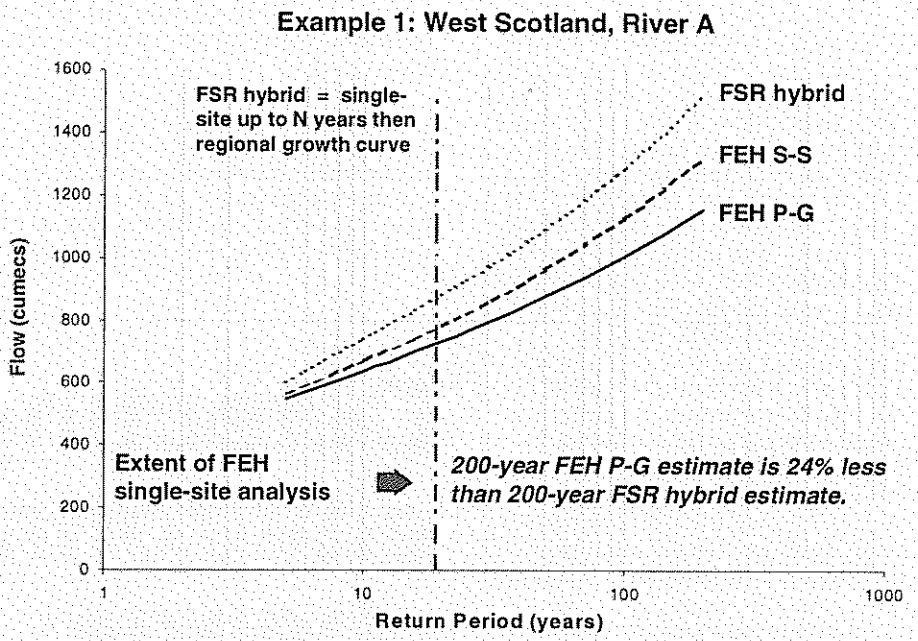
Pooling-group membership
It is difficult to establish a satisfactory pooling-group of similar catchments when the subject site has a catchment that is unusual (for example, for small and/or permeable catchments).

Pooled flood growth curves
Do flood frequency curves tend to be flatter when the pooling procedure is used in preference to just using data available at the subject site (site analysis)? This concern was shared by a number of users, but was based on a limited number of case studies. It was also noted that flood growth curves derived using the pooling procedure tended to be flatter than the rainfall growth curves.

Comparing the pooled and single site growth curves for a large number of sites across the UK showed, however, that the pooling procedure could give either steeper or flatter growth curves than those using site analysis. There appeared to be some geographical clustering of sites tending to flatter or steeper growth curves, which was likened to a map showing the residuals of QMED estimation from catchment descriptors.

Standard error of estimate
The standard error of an estimate is rarely referred to. All flood frequency curves have an error of estimate but we tend to ignore this information. It was suggested that in a way we are using standard error when we specify a return period. Some people were using the 95 percentile confidence interval.

Estimating peak flow of frequent events
The FEH statistical method is intended principally for return periods between 2 and 200 years. Flood frequency estimates for return periods of less than 2 years are sometimes required. Current guidance is to consider data transfer from a suitable donor catchment. A problem arises when no suitable donor can be found.



Different methods – different estimates?

With **David Richardson** (Department for Environment, Food & Rural Affairs) in the chair, **Alistair Cargill** (Scottish Environment Protection Agency) presented his *"Comparison of FEH and FSR estimates of design flood magnitudes in Scotland"*.

Both FSR and FEH statistical methods for flood frequency estimation were implemented to compare the resultant design flood magnitudes. Alistair presented the results for three sites in Western Scotland. The FEH pooling-group generally gave lower design magnitudes than the FSR 'regional' analysis. The growth curves parameters defined using the FSR regional approach were not derived from a homogeneous flood region, which might partially explain the differences. Nevertheless acceptance of the FEH pooling-group curve was difficult in a number of cases.

"Reconciling FEH statistical and rainfall-runoff estimates – case studies, issues, and concerns" by **David Price** (Babtie Group) began with a comparison of FEH and FSR design rainfall depths for different durations, which showed that depths derived using the FEH procedures were typically higher. He went on to illustrate the effects of a 10% increase in design rainfall on design flow for some example catchments in Scotland. The FSR rainfall-runoff model had essentially not been changed for use in the FEH but was being used with new FEH design rainfall inputs. He suggested that the model needed to be re-calibrated in the light of this. When reconciling differences between estimates produced by the statistical and rainfall-runoff methods, David recommended a hybrid approach.

Summary of discussion

Rainfall-runoff method
In comparing flood frequency estimates produced using the rainfall-runoff (RFRO) method, plots of mean residual versus return period showed that design flood estimates based on FEH design rainfall inputs were considerably higher than when FSR estimates of rainfall were used. The use of observed data improved quantile estimates. The impact of using SPRHOST had been considered and the FEH method had been found to overestimate observed flood quartiles for catchments with SAAR values of less than 800 mm.

Design inputs to the rainfall-runoff method
There was some discussion of problems resulting from the use of the FEH design rainfalls with a rainfall-runoff method that had originally been calibrated using FSR rainfall data. A new project had just been commissioned at CEH Wallingford to reconsider, among other things, the design inputs to the method. The opinion was expressed that it was the method of design storm derivation, rather than the use of the FEH rainfall estimates *per se*, which was the root of the problem.

The seasonality of the rainfall inputs was felt to be a problem: in north-west England the greatest magnitude storms generally occurred during the winter, while in south-east England summer storms were likely to be more extreme. Thus, in the south-east, problems with the RFRO method were not necessarily related to permeable catchments.

Problems with the rainfall-runoff method
The use of $Tp(0)$ and SPR values from data did not always give better flood quantiles than the use of catchment descriptors. This was an area worth considering for further research.

It was suggested that the use of unit hydrograph shape information would improve the results of the method. Again, this was something being considered in the new project.

Rainfall frequency estimates for reservoir safety
Panel engineers were particularly concerned about problems in FEH methods relating to very long return periods (2000 to 10 000 years). No news was available about further research on this subject. It was suggested that the FEH CD-ROM should warn the user when rainfall return periods of over 1000 years were being selected.

Flood peaks, levels and volumes
Other methods that could be used to synthesise hydrograph shape were highlighted, for example adopting a model of hydrograph width, or averaging observed hydrographs. Flood volume analysis was another useful technique. It was agreed that level, flood peak and flood volume were all very important issues.

Session 3 — Research and applications

Ann Calver (CEH Wallingford) chaired this informal session. **Con Cunnane** (National University of Ireland) began by announcing plans to produce new flood estimation procedures for the Republic of Ireland. The Office of Public Works is currently considering the programme and expects to release more details in due course.

Lisa Stewart (CEH Wallingford) presented a brief outline of a new project to revitalise the FSR/FEH rainfall-runoff method in the light of the changes made to the design inputs as a result of the publication of FEH Volume 2. The project aims to improve a number of key components of the method, including design storm definition, antecedent soil moisture conditions, percentage runoff and unit hydrograph form.

John Packman (CEH Wallingford) demonstrated how the FEH statistical

and rainfall-runoff methods were being used together in the Modelling and Decision Support Framework (MDSF), developed for the EA Catchment Flood Management Plan (CFMP) programme. CFMPs are meant to provide a broad-scale review of flooding issues in a catchment, to assess impacts of land-use and climate change, and to assess options for minimising flood damages. The MDSF is GIS-based, with thematic layers including the FEH digital catchment boundaries and the automated FEH statistical estimates described earlier by Dave Morris. Flood hydrographs from selected sub-areas (around 20) in the catchment are estimated 'off-line' by the FEH methods and are routed through the catchment using the iSIS river model. Flood levels are entered into the MDSF to calculate flood outlines and damage costs.

John demonstrated a spreadsheet implementation of the FEH rainfall-runoff model, allowing direct comparison with the statistical method at a range of sites. Overall differences between the methods could thus be assessed and resolved, and the effect of changes in sub-area land-use or flood control works could be investigated.

Summary of discussion

Catchment Flood Management Plans (CFMPs) and Modelling and Decision Support Framework (MDSF)
Although the MDSF is intended to simplify the procedure of developing CFMPs, this does not mean that the software should be used by an unskilled person, but rather that the software enables the experienced user to spend more time considering the complex issues involved and exploring the sensitivity of the results to various decisions.

Revitalisation of the FSR rainfall-runoff method as presented in FEH Volume 4
There was much interest in this recently started project, and several users had their own suggestions about what elements of the method should be revisited. There was general consensus that the 'ingredients' of the FSR 'recipe' for generating a design event needed to be reviewed. Other issues mentioned were variation of percentage runoff and standard percentage runoff with event magnitude, seasonality of catchment wetness, and unit hydrograph shape.

Comparison of results from FSR and FEH methods
There were two main issues here:

- Why does the rainfall-runoff method consistently give larger flow peaks than the statistical method, in both the FSR and the FEH, and
- Why does the rainfall-runoff method often give higher flow peaks with FEH rainfall than with FSR rainfall?

Following on from the latter issue were the consequent implications for reservoir safety.

It was felt that it was not always acknowledged that the statistical and rainfall-runoff methods are fundamentally different: the statistical method is an output model based on flow data at gauging stations, whereas the rainfall-runoff method is an input model based on rainfall data and routing. Therefore, it is expected that the statistical method may give better results. However, there is a continuing role for both methods, provided that the underlying assumptions and limitations of each are recognised.

Adrian Bayliss
CEH Wallingford

Detecting environmental change: science and society

University College London
17-20 July 2001

This four-day conference was designed to bring environmental scientists together to discuss approaches to detecting environmental change at a range of scales. In total 62 oral papers and 220 posters were presented. The following is a personal outline of a selection of the research presented and the nature of the discussion at the conference.

There were plentiful examples of excellent long-term datasets, including work in phenology, remote sensing, coastal survey, freshwater dissolved organic carbon and many more. However, often these datasets were fraught with problems. **Ian Strangeways** (Terradata) argued, for example, that the errors involved with historic meteorological instruments were so bad that we should scrap the entire record and start again with a new global network of meteorological recording.

Others disagreed, however, suggesting that a great deal of work had been done in calibrating historical records and that it would be a waste of valuable information to scrap these. **Rick Battarbee** (UCL) noted the deficiency of many records – often data collection only begins after a problem has been identified. The importance of establishing the baseline or natural variability within ecosystems was emphasised in order for us to determine current change within this context and to help us apply remediation techniques.

Herman Hummel (NIOO-CEMO) provided discussion of a macrobenthos problem in the Netherlands. Here the loss in biodiversity went undetected for years even though relevant data were collected. This highlighted the need for data analysis, rather than simply data storage, which many government agencies have solely been involved with. Similarly **Tim Burt** (Durham) highlighted that long-term monitoring by government agencies in the past is often very useful to us now but that problems could have been identified much earlier if the agencies had realised the importance and the implications of data collected. He also noted that change in hydrological systems could be detected by experimental manipulation, palaeoenvironmental investigation, land use modelling (which has often involved crude black-box techniques), and long-term monitoring. Justification for long-term monitoring of hydrological processes comes from the fact that many processes are slow, rare events need long-term recording to pick them up, many hydrological phenomena are episodic or pulsing in nature and many changes are very subtle. Furthermore hydrological systems exhibit complex response in

time and space where landscape sensitivity, resistance and resilience were important factors. In light of the problems associated with uncertainty and complex response in the environment Peter Young (Lancaster) questioned our traditional modelling approaches to environmental change. Surprise was expressed at the current dominance of deterministic models when the environment was so uncertain. Young therefore proposed the use of data-based mechanistic models that allowed appropriate uncertainty analysis and allowed us to question elements of the models themselves.

One of the key themes to emerge from the conference was that globally and locally disparate relaxation times often make process-responses difficult to identify. The conference provided many examples of the old land use change versus climate change nemesis although several scientific breakthroughs allowed policy development. For Bob Foy (Department of Agriculture – Northern Ireland), increased phosphorus loading in Lough Neagh was a response not to population pressure, fertiliser or sewage sludge but to the practice of manuring the land, which caused changes in soil phosphorus retention capacity.

Few of the papers presented examined environmental change from an economic perspective but it was good to hear David Pearce (UCL) who noted that humans pollute the environment for three main reasons:

(a) There are too many of us;
(b) We have incorrect incentives in operation (e.g. CAP subsidies), and
(c) There is an absence of property rights to natural resources.

Trading of water in Australia and worldwide carbon trading were seen as important ways forward but it was emphasised that we need improved focus on identifying and analysing the fundamental causes of degradation; causes that lie in the mis-design of political and economic systems. Graham Harris (CSIRO Land and Water, Canberra) suggested that Australia leads the world in trading water. He noted that saline drinking water was excellent for focusing the political and public mind on an environmental problem caused by tree removal leading to groundwater leakage. Australian river regulation ruined biodiversity but now a National Action Plan costing $1.4 billion over the next five years aims to tackle the interlinked issues of water quality, biodiversity, land use management and public perception. Community liaison has been identified as a key factor in the project and removing unsustainable wheat crops and the new science of bush crops were seen as steps forward.

The whole conference had a great international and trans-national feel to it and examples of data integration were pulled from around the world. A major underlying theme that emerged from many of the papers presented was that spatial changes were often far greater than at-a-point temporal changes. Thus monitoring, assessment and remediation needed to consider the spatial aspects of environmental change.

Two papers really highlighted this for me. The first (by **Hugh Sweatman**, Australian Institute of Marine Sciences) was on the vast spatial changes to the Great Barrier Reef that occur following storm surges or bleaching events. The second was by Kevin Bishop (SLU Dept of Environmental Assessment, Sweden) on the spring flood in Sweden. A baseline pH of 6 was determined in the 1980s for Swedish lakes but the spring floods frequently decrease lake pH to below 6. Hence liming of Swedish lakes to achieve pH above 6 has been undertaken for many years. However, this paper showed that the reference level of 6 was determined for lakes in the south of Sweden, yet many of the northern lakes were *naturally* below a pH of 6 during the Spring melt season. Hence the liming was not appropriate in the north of Sweden.

Several papers highlighted ways of engaging environmental science with the public and policy-makers much more intimately than at present. **Diana Wall** (Colorado State University) explained the principles behind International Biodiversity Year (IBOY), which aimed to pull together multiple datasets, show inter-linkages between habitats, and (as a way forward) map, plan and calculate those species most sensitive to change. As part of this, public involvement was important.

Jeremy Greenwood (British Trust for Ornithology) showed how communicating science to the public is the key the getting action, and that farmland birds were a great example of how these measures can succeed. There were lots of good attempts to show how websites and school visits could promote public interest and involvement in science — e.g. **Terry Parr** (UK Environmental Change Network), **Jonet Ward** (Lincoln University), *Waterwatch*, New Zealand and **Hague Vaughan** (EMAN, Environment Canada).

Gabrielle Kuiper (University of Technology, Sydney) suggested that we should all be aiming to improve how we communicate with policy-makers. Scientists and policy-makers should enter a mutual dialogue so that scientists know what policy-makers want and are able to meet their needs and the policy-makers are better able to understand the science. **Frans Berkhout** (Sussex) presented a paper showing that we often see the science-policy process in a linear model of detection followed by analysis then advice and finally policy. Berkhout showed that this was not the best model – science informs but good science does not lead to policy interest and action. For example we often need a charismatic figure. Science and policy are co-constructed – policy communities define what is useful, although under special circumstances science can define what is useful, but only until a policy community is formed. In the light of this it seemed necessary that any follow-up conferences would need to involve representatives of the public, industry and policy-makers.

In summary, this conference suggested that hydrologists should be working much more closely with other scientists. More data integration is required. Certainly the work I presented on the recent climate changes evident in the longest upland instrumental record in the UK (at Moor House, in the north Pennines) would benefit from biological and geomorphological collaboration. This is because annual warming has been concentrated during the winter months and the most important changes seem to revolve around the frequency of frost, which has been 25% less frequent since 1990 than it was between 1930 and 1980.

Thus there are many interlinked biological, biogeochemical, hydrological and geomorphological implications. We need more global meteorological and hydrological networks tied to biodiversity and quality of life indicators. These needs are small, however, compared to the problems we face in communicating hydrology to a wider audience. Hydrologists should seek to interact more with the public and with policy-makers in the future. We must develop more accessible information and be part of a two-way dialogue with the public and policy-makers. We should not be aiming simply disseminate our science but to communicate with people.

Personally I came away from the conference realising that there was something deeply wrong with the scientific funding system for a young hydrologist like myself. The pressure to produce papers rather than to help develop relevant management practices is overwhelming. The funding bodies see papers as outcomes rather than simply a platform for policy. A complete scientific study is more than just a publishable paper and science will fail without more interaction between scientists, the public and policy development. The way funding bodies are organised and they way they perceive outcomes of scientific research needs to change if we are to make significant progress in environmental change policy.

Joseph Holden
School of Geography
University of Leeds

Recent advances in hydro-ecology

BHS National Meeting
Institution of Civil Engineers, London
25 October 2001

The day was introduced by *Malcolm Newson* (University of Newcastle upon Tyne), who on his journey on the London tube system was warned to "mind the gap", reminding him of the inherent and vast gaps that exist in the necessary interdisciplinary framework for research and applications in hydro-ecology.

Malcolm went on to liken hydro-ecological attributes of rivers to a bed, which included and "morphological mattress", a "hydraulic sheet" and a "hydrological duvet". Geomorphology, which has only recently been identified as important in river management, has entered a classification phase, with river "styles" (channel typologies based on dimensions and features) being offered to ecologists for research instead of stream order. The "hydraulic sheet" requires knowledge of flow types, which at a descriptive level give a good indication of the velocity profile and structure of the flow column. However, modelling of the boundary layer and turbulence remains problematic.

Finally under his "hydrological duvet", Malcolm argued that flow exceedance (based on 15-minute discharge data) should be used and it was vital to interpret flood and drought cycles in habitat terms and their effects on the "morphological mattress". He called for a research agenda to include developing an empirical picture of river channel dynamics, an inter-disciplinary research site network, use of flow information to index regime and variability (70-80% of flows in the UK are not natural) and a better understanding of "heavily modified" channel morphologies, given that 60% of the UK's channels have been modified in some way.

Mike Acreman (CEH Wallingford) described the difficulties of turning theory into practice and offering predictions on ecological impacts: if knowledge is not sound, we must make the use of "best science", state clearly what models can and cannot do, state what remains expert judgement and give estimates of levels of confidence.

David Harper (Leicester University) gave a presentation on defining invertebrate habitats from the 'bottom up'. Fifteen years ago 'engineers ruled', in that the main motivation for channel management was flood defence. However, with the recent development of schemes such as SERCON and RHS, there is now an increasing requirement for knowledge of river form, function and ecological processes in river rehabilitation. To break the dominance held by engineering technology, a simple scheme was needed that would include a visually recognisable methodology for identifying important areas of channels. It has long been accepted by ecologists that high physical heterogeneity delivers habitat diversity, but this relationship has rarely been assessed quantitatively.

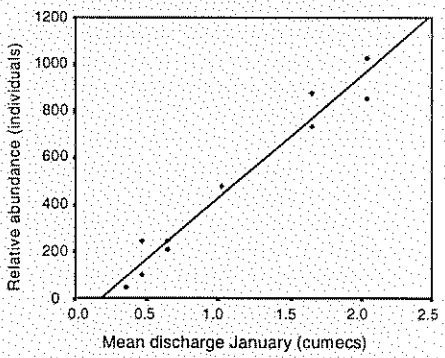
'Functional habitats' are a named set of meso-habitats that together encompass the entire wetted channel. They are structural components of the substrate and vegetation, objectively identified as distinct by their assemblages of invertebrates. The method can be described as 'bottom up', since it is validated biologically rather than described subjectively or initially by geomorphology. For each functional habitat, depth and velocity occurrence preference matrices are plotted against flow types (biotopes), leading on to defining a link between the distributions of habitats and the Froude Number. Discussion concluded that Froude Number (which combines depth and velocity and is related to flow types) is more definitive than simple descriptors of habitats such as 'riffle', 'pool' and 'glide'.

Paul Wood (Loughborough University) talked about the hydro-ecology of stressed habitats. He summarised the work of Lake (2000), describing perturbations in ecosystems consisting of two events: the disturbance, marked by the application of the disturbing forces, and the response shown by the biota to the damage inflicted by the disturbance. A disturbance may take the form of a *pulse*, e.g. floods or point source pollution, a *press*, e.g. dams or channelisation, or a *ramp*, e.g. drought or sedimentation. The consequent trajectory of the response may also be a pulse, a press or a ramp. During recovery, there are changes in biotic composition and spatial configuration in habitat patches. Resistance and resilience of the biota to disturbance may be facilitated by the use of refugia. For example, during a flood biota may colonise habitats not affected directly by the flood, such as backwaters.

In the Little Stour River, Kent, changes in macroinvertebrate community responses to climatic and discharge variations have been monitored over a range of hydroclimatic conditions, including the 1989-92 and 1996-97 droughts (when parts of the river bed were exposed) and during the 2000-01 flood events. Macroinvertebrate samples were collected and analysed within the same week in September over the period 1992-2001; discharge data and air temperature data were collected, along with local historical information from the Environment Agency and the local community.

Correlation and regression analyses highlighted the dominant hydro-climatological factors influencing community abundance of macro-invertebrates at a range of spatial scales including the entire river, upstream and downstream sections and riffle sites. Temporal sequencing of annual air temperature and discharge regimes, from the period 1969-99, were used to put sample results in a longer-term context. Regime analysis revealed inter-annual variability in discharge and air temperature.

Variance analysis revealed different macroinvertebrate community abundances for the hydrograph shape and magnitude, at all scales of analysis: influence of air temperature only varied significantly between riffle sites.



Relationship between mean discharge in January and relative abundance of macroinvertebrates (Site 6)

Paul highlighted the need for more long- to medium-term studies on hydroclimatological variability and its implications for instream ecology, looking at the most sensitive components of discharge, air and precipitation regimes, thereby providing essential information for the ecological sustainability of water resources.

Chris Gibbins (Aberdeen University) asked "How much water do spawning salmon require?" After briefly highlighting managers' and fish ecologists' scepticism about PHABSIM, Chris said that it was possible to use

direct observational data of spawning site selection by Atlantic salmon to assess discharge requirements, in an attempt to avoid errors generated with hydraulic simulations, problems associated with micro-habitat suitability indices and cell composite suitability, and conceptual difficulties in using Weighted Usable Area. The method tries to identify suitable discharges for spawning to generate further questions about hydraulics to assess whether a site is more or less suitable for spawning. Work took place on Girnock Burn, a tributary of the Dee (catchment area 30 km^2, average width 3 - 6 m). During three consecutive spawning seasons, four weeks of daily field walking recorded evidence of spawning activity, i.e. female salmon cutting redds. Time and location of the activity was noted and spatial information was related to distance upstream for 428 observations; location-specific discharge for each of the spawning observations was estimated; the predicted values were validated using field measurements of discharge at the weir on the burn.

Results showed that most spawning sites occurred in low gradient sections, some locations were used regularly and others infrequently, sites were used across a broad range of discharges, and minimum flow was utilised by the salmon: this increased in significance the further upstream in the catchment. The method is still in its developmental stage but preliminary results suggest that it may prove useful, as it avoids errors and assumptions that are a contentious part of PHABSIM. However, it cannot be applied to juvenile salmon numbers, and although the method is simple it is very data intensive. In terms of answering the original question ("How much water do spawning salmon require?"), discharge requirements vary within a catchment. This may be due either to hydraulic requirements or to access problems. The research can clearly offer management implications in that siting a abstraction point upstream would have a much more marked effect on salmon numbers.

Mike Dunbar (CEH Wallingford) described a field programme on four rivers (two Chalk: Piddle and Frome; two upland: Senni and Walkham), designed to enhance the PHABSIM calibration methodology. Mike said that some of the criticism of PHABSIM did not reflect the technique's flexibility in relation to data inputs. The programme therefore took a more detailed, more varied approach to the collection of depth, velocity and substrate data and used mesohabitat mapping as the basic sampling framework (cf. the normal stratified transect sampling). Correlation between the more intuitive and more disciplined approaches were high in most cases but Mike considered that the biggest remaining problem was the application of measurements in 'safe' flows to the extremes of the hydrological regime. One of the most revealing outcomes from the unbiased measurement of velocities was the importance of edge effects.

Anton Ibbotson (CEH) spoke about Habitat Suitability Indices (HSI's), which represent a function between an independent variable and the response of an organism to that independent variable. Methods for developing HSI's include professional judgement, experimental procedure and surveys of habitat use. HSI's were developed for trout and salmon at a number of rivers in the UK. Many factors affect habitat use by fish but this study used species, size, season, physiological stability and habitat availability. It was concluded that site specific HSI's are expensive and not always practical, as they are dependent on site and season, as determined by habitat availability. Therefore, in the application of PHABSIM, generic HSI's based on habitat preferences are better.

Andy Tagg and **Mike Crafer** (Thames Water) gave an end-user view of applications of hydro-ecology: their joint presentation was on "Restoration of the River Kennet". The Kennet in Wiltshire not only provides an abstraction point for Thames Water Utilities plc, but is also a designated SSSI, of ecological value in terms of forestry and recreation, and visually is a community amenity. However, in 1989/90 it was the local community who first noticed the deterioration of the river in terms of flow levels and visual impairment, and blame was initially directed towards Thames Water Utilities plc for their part in abstraction and wastewater treatment. In 1994, the Environment Agency proposed cutting Thames Water's licence for abstraction from 9 Ml to 3Ml per day over the next ten years.

Thames Water appealed against the decision and the Secretary of State called for a public inquiry (the Axford Inquiry) to decide the future of the case. This was the first time that a renewal of an abstraction licence had been refused on ecological grounds. The Inquiry considered the computer modelling work of PHABSIM, which supported the view that *ranunculus* could suffer at flow rates in the order of those associated with the Axford abstractions. The eventual findings of the inquiry represented a compromise between the wishes of Thames Water, who wanted to abstract as much as they needed, and the Environment Agency and other bodies, who wanted to restrict abstraction and gradually reduce it over time in order to protect the river.

The major outcome of the inquiry was a rehabilitation project for the River Kennet. Work has involved a series of projects, primarily funded and co-ordinated by Thames Water. Working with the Environment Agency, English Nature, "Action for the River Kennet" and many other interested parties, the project aims to rehabilitate physically degraded reaches of the river. A key objective is to improve the sustainability of habitats and species most characteristic of chalk rivers. It aims to increase understanding of key ecological processes, repair historic degradation, enhance SSSI status, provide self-sustaining fisheries and test new river enhancement techniques. Pre- and post-project monitoring primarily using macrophytes will be used to assess usefulness of the rehabilitation techniques used.

The final presentation "Resource assessment and management framework: applying hydro-ecology with Catchment Abstraction Management Strategies (CAMS)" was by **Aileeen Kirmond** and **Douglas Wilson** (Environment Agency) and highlighted why regulators need science. In April 2001, the Environment Agency began producing Catchment Abstraction Management Strategies for all catchments in England and Wales. One of the main objectives for CAMS is to provide a consistent and structured approach to local water resources management, recognising both the abstractors' reasonable needs for water and the needs of the environment.

To help deliver this objective, the Agency has developed a tool called the Resource Assessment and Management (RAM) Framework, which builds on the integration of knowledge, existing best practice and recent work in the fields of water resources management and hydro-ecology. The approach explicitly recognises the inter-connection of surface water and groundwater and gives Agency staff a mechanism for considering the impact of water abstraction on the hydrological system so they are able to assess resource availability in a more holistic way. A catchment is divided into a number of river reaches and groundwater management units. Each river reach is bounded by an Assessment Point and an Environmental Weighting of the reach is derived, based on scoring four different factors: physical characterisation, dominant fish populations, macrophytes and macro-invertebrates. The scores for each factor are then combined to give an Environmental Weighting Band, which characterises the sensitivity of the ecology to flow variation.

Along with long-term flow duration data, the Environmental Weighting is used to derive an Ecological River Flow Objective, after which an assessment is made of surface water resource availability. This is based on an estimate of naturalised river flows and the actual or potential impact of water abstractions and discharges on those flows. Where possible, groundwater

resources are considered in relation to the surface water catchment divisions, and a number of independent checks are made as part of the groundwater resource assessment to ensure that an adequate balance between recharge and abstraction is maintained. Results are then integrated with the surface water assessment and used to assign a resource availability status to each river reach and groundwater management unit. This in turn is then used to derive an overall strategy for managing the catchment. There are four classes of resource availability status: water available; no water available; over licensed and over-abstracted.

The results of the resource assessment and he proposed strategy for managing the catchment are the fed back into the CAMS sustainability appraisal and consultation process and, once finalised, provide the framework for the management of catchment resources over the six-year CAMS cycle for the catchment. The integrated approach of the RAM framework will be essential in the delivery of not only CAMS, but also the requirements of the European Water Framework Directive (WFD) that will force consideration of water management and protection in a more holistic way. The launch of the RAM framework therefore puts the Agency in a good position to respond to some of the water management challenges posed by the WFD within the relevant Directive timescales.

The meeting was an experimental 'testing of the waters' by BHS. As a result of the high level of satisfaction from the 80-strong multi-disciplinary audience, it will be repeated after a couple of years. It is also hoped to forge a longer-lasting joint approach between BHS and the Aquatic Ecology Group of the British Ecological Society.

Claire Walsh
University of Newcastle upon Tyne

Controversial issues in environmental science

The Natural Environment Research Council is sponsoring an environmental issues debate forum on the Internet, starting with the topic of global warming and the Kyoto Protocol. This will be followed by debates about genetic modification, renewable energy, waste disposal, water resources and environmental ethics.

NERC is hoping to stimulate dialogue in the wider social and ethical context of issues in which science plays a part, even though it might not always agree with the views expressed. You can find it at http://www.spiked-online.com/sections/science/debates/kyoto/default.htm.

Book review

"Productive Water Points in Dryland Areas" by Chris Lovell, ITDG, 2000, ISBN 1 85339 516 1.

I experienced a feeling of regret as I read this book at the beginning of the year 2002. My regret was that I had not done so sooner. *Productive Water Points in Dryland Areas* presents a detailed, integrated and informative analysis of community-managed water sources, which provide water for economically productive purposes. It is based mainly on research carried out in Zambia and Zimbabwe in the 1990s, although it draws on wider experience over a longer period of time.

The book should be of value to both technical specialists and social scientists working in any developing country in which water is used at community level for agriculture or small-scale rural industry. However the main focus of the book is on *groundwater*, in *dry areas* underlain by *crystalline Basement* rocks, and on the use of that water for community- or farmer-managed (small-scale) *irrigation*.

Chapter 1 provides an introduction, with definitions of *Productive Water Points*, the benefits which can result from their use, and problems which they may give rise to. *Chapter 2* is a sound layman's guide to the main technical issues involved in groundwater hydrology in dryland crystalline Basement: this is unique in my experience. *Chapter 3* sets out a very detailed analysis of the financial and cost/benefit issues surrounding productive water points. My only criticism here is that, like the results of any financial analysis, the absolute figures are time-bound. Nevertheless the relative results probably have longer-term relevance, at least within southern Africa.

Chapter 4 very usefully addresses the issues involved in rehabilitating, re-siting or re-constructing existing water points. This is of great relevance in many countries where groundwater sources lie unused, or inappropriately used, for want of such attention. *Chapter 5* moves on to the design, siting, and construction of new groundwater sources. How refreshing to read a realistic assessment of geophysical survey methods in such environments, and to see an appropriate emphasis placed on test drilling to prove water. *Chapter 6* provides a helpful guide for the development of partnerships with communities — again unique in its succinct and practical emphasis.

Chapter 7, the penultimate chapter, concludes the main body of the book by dealing with the management of productive water points. Finally *Chapter 8* puts the remainder of the material addressed in the book in the context of current development paradigms, such as sustainable livelihoods and integrated water resources management.

Many interlocking issues are raised and discussed in some detail in this book. Perhaps it is unfair to pick on single issues that have been omitted or given insufficient weight. Nevertheless, given that financial and community aspects are discussed in such detail, as well as technical aspects of irrigation management, it seems odd that the discussion of produce markets and marketing only justifies a page and a half. Perhaps this minor criticism reflects less on the book and more on the wide-ranging and integrated nature of its subject matter, which would challenge any author to fully address it in one 200-page paperback.

If you are involved in rural water supply development, especially if that water is likely to have uses beyond simply the domestic, then I strongly recommend that you read this book.

Dr Richard C Carter
Institute of Water and Environment
Cranfield University at Silsoe

BHS travel grants and 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*, and there are some in this issue.

The Exeter Fund, looked after by BHS, also pays grants, specifically to help British hydrologists to participate in IAHS activities.

To apply for a grant, please contact the Hon. Treasurer, **Steve Parsons**, Mott MacDonald Ltd, Demeter House, Station Road, Cambridge, CB1 2RS *(tel 01223 463926, email sbp@mm-camb.mottmac.com).*

Copy deadline for *Circulation* No. 73 12th April 2002

C+ Circulation PLUS

A source of bias in regionalisation equations

This C+ contains an article by committee member **Ian Littlewood** on bias in regionalisation equations, using an example from the FEH, and **John Rodda** compares the view from the world freshwater conference in Bonn with the water and environment conference ten years ago in Dublin.

If you have something to share with other members, these pages are for you. Articles on climate change or socio-economic aspects of hydrology would be particularly welcome next time. Please send your contributions in good time for the next issue (see the box on page 8).

Ian Littlewood
Centre for Ecology and Hydrology

A look at bias in regionalisation equations for estimating rainfall-runoff model parameters and flow regime indices at ungauged sites, illustrated with an example from the FEH

This article discusses the phenomenon of 'regression back-transformation bias' and its presence in regionalisation equations, e.g. the introduction of bias in unit hydrograph parameters or river flow regime indices estimated from physical catchment descriptors. A regionalisation equation from the Flood Estimation Handbook[1] is used to illustrate aspects of the problem. The need to investigate new regionalisation techniques and procedures for synthesising hydrographs at ungauged sites operationally is outlined.

Chapter 17 of the Handbook of Hydrology[2] describes how, after regressing $log(y)$ on $log(x)$, systematic error (bias) can be introduced when the regression equation is back-transformed to obtain an expression for estimating y from x. The sequence of regression analysis using logarithms of variables followed by back-transformation to the initial domain of interest is applied in several areas of research hydrology. The results can form an important part of operational and design hydrology procedures undertaken by consultants, environmental agencies, etc. Statisticians have known about regression back-transformation bias for some time[3], though relevant texts do not always deal with the issue[4]. Hydrologists, apparently, are not well informed about this potential problem in regionalisation schemes.

Ferguson introduced the phenomenon of regression back-transformation bias in the context of river mass load estimation[5]. A common situation when estimating river mass loads is that flow data are available on a regular, high-frequency, basis but concentrations are measured less frequently (and in many cases aperiodically)[6]. Suppose x and y plot as shown in Figure 1 (x is flow and y is nitrate concentration at a primary monitoring site in the UK). The lack of evidence for a linear relationship between flow and concentration in Figure 1, and the increasing variance in concentration with increasing flow, means that the assumptions of the linear regression model are not valid in this case. However, a simple best-fit relationship between the two variables is often sought in this kind of situation in order to be able to estimate concentrations from flows, e.g. on a daily basis. A mass load can then be calculated, involving the sum of products of flow and estimated concentration at each time step.

Plotting the points in the logarithmic domain (Figure 2) straightens up and 'conditions' the scatter, and invites linear regression of $log(y)$ on $log(x)$, where the model is given by equation (1):

$$log(y_i) = log(a) + \alpha\, log(x_i) + \varepsilon_i \qquad (1)$$

where i denotes the i^{th} of the n values used for the regression analysis and ε_i is an independent additive error term from a normal distribution that has a mean of zero and a variance denoted by σ_ε^2, i.e. $N(0, \sigma_\varepsilon^2)$. (As in Figure 2, the scatter may indicate that, strictly, the ε_i

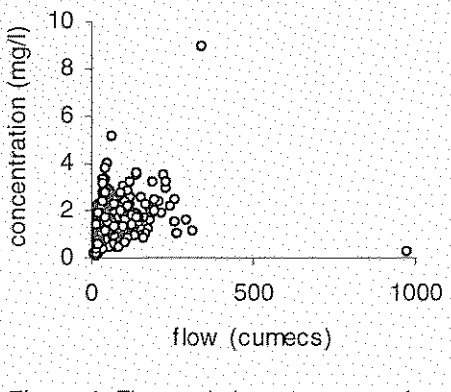


Figure 1 *Flow and nitrate concentration*

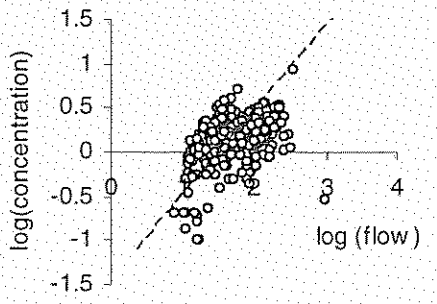


Figure 2 *Log flow and log nitrate concentration*

might not be from a normal distribution, but in practice a pragmatic approach prevails and this point is often overlooked, as it is here, for simplicity.) After regression analysis to estimate $log(a)$ and α, equation (1) is back-transformed to equation (2),

$$y_i = \eta_i \alpha x_i^{\alpha} \quad (2)$$

where $log(\eta_i) = \varepsilon_i$. The multiplicative errors, η_i, are therefore assumed to be log-normally distributed, in which case if natural logarithms are used in the regression analysis, the expected value of η_i is given by equation (3)[3].

$$E(\eta_i) = \exp(\sigma_\varepsilon^2/2) \quad (3)$$

It can be seen from equation (3) that the bias is zero (i.e. $E(\eta_i)$ is unity) only if there is no scatter ($\sigma_\varepsilon = 0$) about the best-fit curve of $log(y)$ against $log(x)$, and that the bias increases as the scatter (σ_ε) increases. In the case illustrated by Figures 1 and 2 $E(\eta_i)$ is about 1.21, i.e. in order to remove the bias, values of y calculated using the back-transformed equation should be multiplied by 1.21. In some cases, if the back-transformed equation is not adjusted, the bias in a river mass load can be –50%[5].

Regression back-transformation bias results in systematic *under*-estimation. If the residuals are $N(0, \sigma_\varepsilon^2 < 0.5)$ and $n > 30$, equation (3) provides "a very good approximation" of the factor which removes the bias; otherwise equation (3) overcompensates for the bias[2].

Multiple linear regression analysis using logarithms of variables is often employed in the derivation of procedures to estimate flow regime indices, or rainfall–runoff model parameters, from physical catchment descriptors (regionalisation). An ultimate goal is to be able to simulate precisely and accurately the continuous streamflow hydrograph, at ungauged sites, from readily available hydrometeorological variables (rainfall, air temperature, etc.) and physical catchment descriptors (catchment size, slopes, land-use, etc.).

The model is given by equation (4):

$$log(y_i) = log(a) + \alpha\, log(x_{1,i}) + \beta\, log(x_{2,i}) + \ldots + \delta\, log(x_{m,i}) + e_i \quad (4)$$

where $x_{1,i}, x_{2,i}, \ldots x_{m,i}$ are the m independent variables (selected physical catchment descriptors); y_i is the model parameter or flow characteristic of interest (e.g. a unit hydrograph response time, specified flow percentile, etc.), and ε_i is the same as in equation (1). The back-transformation of equation (4) is given by equation (5).

$$y_i = \eta_i a x_{1,i}^{\alpha} x_{2,i}^{\beta} \ldots x_{m,i}^{\delta} \quad (5)$$

(Other transformations might be used in regionalisation schemes, e.g. the square root, but only the logarithmic transformation is considered here.)

Regionalisation procedures in the *Flood Studies Report* (FSR)[7], the *Flood Estimation Handbook* (FEH)[1] and many other publications[8] use back-transformed models of the form given by equation (5) but do not discuss the possibility of bias in the results. The FEH equation for regionalising the time to peak of the FSR-defined triangular unit hydrograph (Tp), given here as equation (6), will be used to discuss the matter further.

$$Tp(0)_{pred} = 4.270\,(DPSBAR)^{-0.35}\,(PROPWET)^{-0.80}\,(DPLBAR)^{0.54}\,(1 + URBEXT)^{-5.77} \quad (6)$$

In equation (6) the independent variable *DPSBAR* is a measure of slope in the catchment; *PROPWET* characterises soil moisture deficit; *DPLBAR* characterises catchment size and configuration, and *URBEXT* is an index of urbanisation. Full definitions of the independent variables, and $Tp(0)$, are given in the FEH. Figure 3 shows, for the 204 catchments used to estimate the parameters of equation (6), the unit hydrograph time to peak estimated from separate runoff events ($Tp(0)_{obs}$) plotted against the corresponding time to peak estimated by equation (6) ($Tp(0)_{pred}$). The variance of the residuals (σ_ε^2) is 0.1512, so according to equation (3), $E(\eta_i)$ is 1.08, i.e. the bias is -8% and, to adjust for it, $Tp(0)_{pred}$ from equation (6) should be multiplied by 1.08.

Unfortunately, to give a reliable bias correction factor for equation (6) is not as straightforward as the foregoing might suggest, for two reasons at least. First, for each of the 204 catchments employed in the regression analysis[9] the dependent variable was not the logarithm of the mean $Tp(0)_{obs}$ for $1 < p < 43$ runoff events but rather the logarithm of the geometric mean of p values of $Tp(0)_{obs}$. The geometric mean of a set of non-negative values is always less than or equal to the arithmetic mean, leading to further underestimation of the unit hydrograph time to peak (the bias is therefore –X%, where X>8).

Secondly, equation (6) was derived using a weighted least squares approach[9]. Ordinary least squares regression minimises the sum of the squares of the residuals but the regression analysis behind equation (6) minimised the sum of weighted (w) squares of the residuals. For a given catchment, $w = 1/\sqrt{p}$. It is beyond the scope of this note to give a bias correction factor to fit these additional circumstances. However, when the objective is to estimate, from catchment descriptors, the mean time to peak of an FSR/FEH triangular unit hydrograph, equation (6) will systematically underestimate that parameter, possibly by much more than 8% because of the additional 'weighted regression' and 'geometric mean' effects. The FSR/FEH triangular unit hydrograph is parameterised solely in terms of its time to peak; if Tp is systematically underestimated the peak will be systematically *over*estimated ($Qp = 2.2/Tp$).

Regression back-transformation bias might be unimportant if the estimate of y is used only as an intermediate value in a procedure to estimate something else (z), provided that the whole procedure is calibrated in some way to assure zero (or minimal) bias in z. In such cases it should be made transparently clear what has been done, and why.

The Institution of Civil Engineers report *Learning to live with rivers*[10] says that we should undertake "continual appraisal of the techniques we use, rather than just reassess our techniques following major flooding events — as has happened in the past." A reworking of FEH regionalisation equations may evaluate the magnitude of any bias due to regression back-transformation more thoroughly and authoritatively than has been possible here. Appropriate bias correction

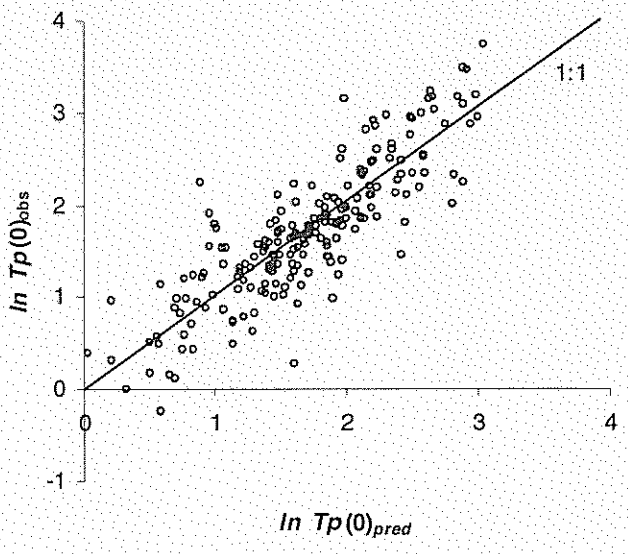


Figure 3 *Observed against modelled unit hydrograph time to peak*

factors could be added where necessary.

It is not sufficient, however, to continually reassess and modify existing unit hydrograph and regionalisation schemes: there is a duty also to consider and develop new techniques made possible by advances in computing power and modelling algorithms.

The rainfall-runoff methodology in the regionalisation scheme for estimating the time to peak of FSR/FEH triangular unit hydrographs at ungauged sites is based on analysis of runoff events at gauged sites, and has remained essentially unchanged since its introduction in 1975. BHS *Occasional Paper No. 13* [11] presents the nature and merits of continuous river flow simulation techniques in possible next-generation flood frequency and low flow estimation schemes [12, 13, 14]. The same report includes an outline and possible applications of a unit-hydrograph-based continuous rainfall-runoff modelling approach [15, 16, 17] that could play a part in such schemes. Further work is needed to investigate the potential of these new techniques in the context of possible next-generation procedures for operational use.

Whatever the detailed nature of next-generation schemes, care should be taken to assess and correct for the bias that might be introduced if constituent model parameters or flow regime indices continue to be derived via back-transformed regression equations.

Acknowledgements

The author thanks **David Marshall** (CEH Wallingford) for supplying the data in Figure 3 and for discussing various aspects of the derivation of equation (6). Thanks also to **David Jones** (CEH Wallingford) for discussing statistical aspects of regression back-transformation bias. The views expressed here are those of the author.

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Dublin ten years on

***John Rodda* shares his view from the International Conference on Freshwater in December 2001 and compares the Dublin Principles of 1992 with the Bonn Keys of nearly ten years later.**

In 1992 the British Hydrological Society was one of the financial contributors to the *International Conference on Water and the Environment* (ICWE), held in Dublin in January of that year. This conference provided the major input on freshwater to the *United Nations Conference on Environment and Development* (UNCED) convened in Rio de Janeiro in June 1992. UNCED produced Agenda 21 — the blueprint for the 21st Century — a statement of principles and several conventions. Much of the report from Dublin is to be found in Chapter 18, the freshwater chapter of Agenda 21, and although ICWE has been criticised, the four Dublin Principles and Chapter 18 have guided most of the water programmes of the United Nations and its agencies as well as those promoted by the development agencies of national governments.

Of course Dublin was one of a series of international gatherings discussing world water problems and how to deal with them. The most recent was convened by the German Government in Bonn, held in the former parliament buildings, the Bundeshaus, on the banks of the Rhine in early December 2001. A few kilometres upstream the German Government was hosting another conference — the one that brought together the different Afghan factions to agree on a way forward for that worn-torn country.

Also known as the "Dublin plus 10 meeting", the International Conference on Freshwater was designed to prepare the water input to the UN World

The Dublin Principles

1. Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment;
2. Water development and management should be based on the participatory approach, involving users, planners and policy makers at all levels;
3. Women play a central part in the provision, management and safeguarding of water;
4. Water has an economic value in all its competing uses and should be recognised as an economic good.

Summit on Sustainable Development, due to take place in Johannesburg in August 2002. This will mark the tenth anniversary of UNCED (the Rio Earth Summit) and the signing of Agenda 21 by 150 or more world leaders.

Some 1200 delegates and observers attended the Bonn Conference, including many accredited representatives of the media. There were 118 government delegations, 46 with ministers, plus 47 delegations from international organisations and 73 from groups and civil society. During the five days there was a closed ministerial session (which produced its own statement), a series of plenary sessions, which came up with "recommendations for action", several working group sessions, and more than 40 side meetings. Each conference pack also contained a series of issue papers, background papers and discussion papers. Once participants had negotiated the security screening, they could wander through a number of stands and exhibits, many technical, some describing UN-based programmes and some announcing future events such as the Third World Water Forum. There were also excursions and social events including (appropriately) a performance of Beethoven's 6th Symphony and a Christmas market.

The Opening Ceremony consisted of speeches from German Government Ministers, the Mayor of Bonn, **Nitin Desai** (UN Under Secretary General) and **Klaus Töpfer** (UNEP Executive Director). The speeches were interspersed with modern dances performed by an accomplished professional troupe. There were no demonstrators or protesters to interrupt proceedings, as at the Second World Water Forum in The Hague in March 2000. Several of the speakers stressed the Conference Theme: *Water — a Key to Sustainable Development* and the importance of water to modern civilisation. None voiced the thoughts of many of the participants that water is ***the key to sustainable development.***

The initial plenary sessions were "multi-stakeholder dialogues", with contributions from NGOs, local authorities, workers, business, industry and other groups under three different themes: (1) Equitable access to and sustainable supply of water for the poor, (2) Developing strategies for sustainable and equitable management of water resources, and (3) Equitable and sustainable use of water resources.

In one of the plenary sessions, the Coordinator, **Gordon Young**, described progress in the UN World Water Assessment Programme and the stage reached in preparing the first edition of the World Water Development Report, which is due to be launched at the Third World Water Forum.

The first working group session dealt with "Governance, integrated management and new partnerships". The second was on "Mobilising financial resources" and the third "Capacity development and technology transfer". Each session was introduced by several invited papers, followed by discussions on the themes addressed. For example, **Arthur Askew** (WMO) took the lead on water data, one of the issues Working Group III considered: the lack of data in many parts of the world, access to data and the policies involved in exchanging data.

One of the side meetings, on "putting water on the top of the political agenda" for the Johannesburg Summit, was arranged by the Water Supply and Sanitation Collaborative Council. The UN Millennium Resolution aims to halve the number of people without adequate drinking water (currently estimated to be 1.2 billion globally) by 2015, but there was concern that similar attention to sanitation was lacking, even though the number of people without effective sanitation was about twice that for water supply. Another of the side meetings marked the launch of the dialogue on Water and Climate instituted by the World Water Council (www.worldwatercouncil.org).

Drawing mainly on the work of the IPCC, invited speakers considered the state of knowledge on climate changes and their likely impact on the hydrological cycle and water resources. Several speakers said that there was little evidence of contemporary changes in river flows that might have resulted from climate change. The Global Water Partnership organised a side meeting to launch their "Tool Box", to help decision makers and water managers better understand the processes and mechanisms for implementing integrated water resources management (www.gwpforum.org).

Reports from the working groups were presented to the plenary session and blended into the draft recommendations of the Conference. Consideration of these was rather protracted and continued late into the evening, despite the best efforts of **Margaret Cately-Carlson**, the facilitator for this part of the programme. An agreed version finally emerged, to be adopted by the Conference at the closing session. Another output was the "Bonn Keys", which, together with the recommendations, will be presented to the Preparatory Committee for the World Summit on Sustainable Development.

The Bonn Keys

Water is essential to our health, our spiritual needs our comfort, our livelihoods and our ecosystems. Yet everywhere water quality is declining, and the water stress on humanity and our ecosystems increases; more and more people live in very fragile environments. The reality of floods and droughts touches increasing numbers and many live with scarcity. We are convinced that we can act and we must. We have the keys:

1. The first key is to meet the water security need of the poor;
2. Decentralization is key: the local level is where national policy meets community needs;
3. The key to better water outreach is new partnerships;
4. The key to long-term harmony with nature and neighbours is cooperative arrangements at the water basin level, including across waters that touch many shores;
5. The essential key is stronger, better performing governance arrangements.

One important proposal made by Switzerland, which was discussed during the plenary but not included in the report, was for an open-ended Intergovernmental Forum on Water. The idea was that through the establishment of a body that might resemble the Intergovernmental Panel on Climate Change (IPCC) water issues would receive continuous attention and gain much greater prominence. Delegations expressed interest in this proposal but asked for more time to study it, so the Swiss will make the same proposal to the Preparatory Committee. The feeling was that establishing such an intergovernmental forum, originally proposed at Dublin, could advance consideration of water to a level not achieved by the various water conferences that have taken place or are planned. It could even lead to moves towards formulating a UN World Water Convention.

It is always difficult to judge the success of a conference. There are no rules that can be followed and few tests to apply. Time has shown that the Dublin Conference was a success, when at the time its impact was thought to have been small. But the water agenda seems to have changed considerably since 1992. There seemed to be a much wider range of interests represented at Bonn than at Dublin, where science and engineering were most important to the debate. Words like access, infrastucture, allocation, equitability, funding, corruption, tariffs and investment characterised the discussions and the recommendations of this Conference. Someone asked me how many people at the Conference would be interested in knowing about the flow of the Rhine as it passed the parliament building!

John C. Rodda
International Association of Hydrological Sciences, CEH Wallingford
(see also http://www.water-2001.de/)

Interfacing hydrological and meteorological models

Fifth International Symposium on Hydrological Applications of Weather Radar
Kyoto, Japan
19 – 22 November 2001

Thanks to the Exeter Travel Fund, I was able to attend and present the results of my post-doctoral research dealing with interfacing radar-based rainfall forecasts with hydrological models. The conference provided a good forum to discuss respective needs between hydrologists and meteorologists.

This conference was hosted by Kyoto University's Disaster Prevention Research Institute and covered three main thematic areas, each occupying one day: precipitation measurements, applications of scaling issues and precipitation forecasting, and hydrologically-based assessments and TRMM.

Each day usually started with a keynote speaker giving an introduction to the topic of the day, followed by short "advertisement talks" for each poster that was to be presented in the afternoon session, providing a good opportunity and plenty of time to discuss work in detail. The day's presentations were summarised in a very fruitful general discussion, pointing to a variety of occurring problems within the community and putting forward interesting ideas.

Towards the end of the conference there was an opportunity to visit the MU (Middle and Upper Atmosphere) Radar at Shigaraki and the Amagase Dam Site, as well as the beautiful Byodoin Temple at Uji. Although not the largest and most powerful, the MU Atmosphere Radar *(see picture)* is generally regarded as the best Mesosphere Stratosphere Troposphere (MST) radar in the world. It comprises an active array of Yagi antennae, each having its own transmit and receive module. This means that advanced beam forming and signal processing can be performed. It measures waves and turbulence — important parts of the energy budget of the earth's atmosphere — almost continuously in the first 80 km, but there is usually a gap region around 40-50 km due to the low amount of turbulence. It can also be used to measure ionospheric structures at more than 100 km from the earth's surface.

The discussion of the *precipitation measurements* session mainly dealt with problems related to the resolution and accuracy of the radar data and the scaling problem, emphasising the differing importance of forecasted volume and timing of the rainfall with regard to the size of the catchment. What statistics or criteria would hydrologists prefer to assess data quality? Inverse modelling — using catchments to measure rain in order to understand the hydrological aspects better — could provide a possibility to advise radar meteorologists how accurate rainfall estimates need to be.

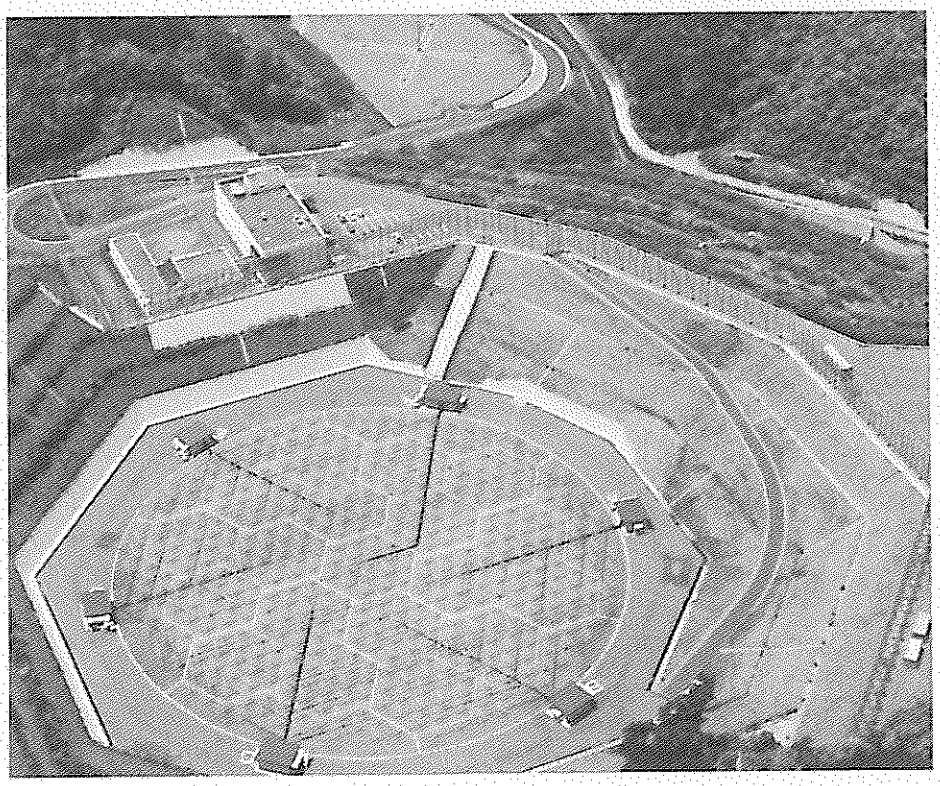
One of those present summarised the "dilemma of the community" in a rather unconventional statement: "Radar meteorologists don't know how accurate radar measurements are and hydrologists don't know how accurate they want them to be." The requirements for appropriate data storage systems — convertible systems, accessibility, record of alterations to radar device — were discussed.

Within the *application of scaling issues and precipitation forecasting* session, the main question was what approach — numerical, conceptual or extrapolation — should be chosen to forecast rainfall for hydrological applications. The overall opinion was that the best approach would be an optimum combination: integrating different data and model sources and making better use of numerical model applications.

The utility of ensemble forecasts dominated the discussion in the *hydrologically-based assessments and TRMM* session, showing that the major obstacle is sometimes the insecurity of hydrological practitioners and their reluctance to use them. Again the advantage of coupled systems — multisensors and several Quantitative Precipitation Forecast systems and hydrological models — was pointed out as the way to go forward.

A selection of conference papers are to be published in a special issue of *Hydrological Processes* on "Hydrological applications of weather radar" later this year.

Susanne Mecklenburg
JCHMR, CEH Wallingford



Observations from the International Phosphorus Transfer Workshop

University of Plymouth
29 August – 1 September 2001

Funding from Imperial College London and a BHS travel grant enabled Russell Smith to present a poster at a workshop organised by the Institute of Grassland and Environmental Research.

The main title was 'Connecting phosphorus transfer from agriculture to impacts in surface waters', split into three themes, covering sources of P on the farm and initiation of P transfer; hydro-chemical connectivity, and impacts of agriculture-derived P on water quality. The final theme 'Integrated catchment management and mitigation of P transfer' linked together the findings of these three themes. I presented a poster entitled 'Calibration and sensitivity analysis of a simple phosphorus transfer model' which detailed the multi-objective calibration of a dynamic (daily time-step) catchment scale model within the second theme. The model links a simple rainfall-runoff model to daily estimates of total P transfer, derived using export coefficients disaggregated as a function of flow.

The conference successfully brought together scientists and engineers from different backgrounds (soil scientists, agronomists, hydrologists, aquatic ecologists and limnologists). Delegates were divided into three rival groups and pitched against each other during both scientific and social programmes, which led to lively discussion sessions during the workshop. Within each theme were specific questions that each group was asked to discuss and come to a consensus on, and the discussion relating to theme 2 (hydro-chemical connectivity) questions was as follows.

Question 1: Is it necessary to distinguish between surface and subsurface pathways when studying P mobilisation?

The pathway P follows from source to impact is crucial, as it will determine the residence time within the system and the form in which P enters the watercourse and thus, the bioavailability. However, even at the plot scale it is difficult to make this distinction. Heterogeneities within the soil profile (preferential flow pathways, e.g. macropores) and the lack of measurement techniques of subsurface systems make it difficult to characterise the underlying processes. Uncertainty (or risk/probability) should therefore form an integral part of model predictions. However, catchment scale hydrology is reasonably well understood and though still uncertain we can predict despite not fully understanding the underlying process. It was therefore agreed that the context in which this question is asked should be considered. For management purposes, especially at the catchment scale should we only be asking simple questions? A lumped approach may be more appropriate in which models distinguish between fast and slow responses rather than surface and subsurface flow pathways. For the identification of 'Hot Spots', vulnerable to P transfer, models need the ability to predict at the field or part of field scale, though due to in-field heterogeneity even at this scale localised processes are difficult to predict. It is clear that model users and policy makers need to accept that some degree of risk (or uncertainty) in model predictions, as deterministic answers cannot be produced. However, for scientific interest it is important to continue this distinction to forward understanding of the underlying processes and the development of more mechanistic models.

Question 2: What is the usefulness of studying P forms during movement from source to impact?

Though there is a need to understand processes, this exercise is very difficult, as forms change rapidly though the landscape and it would therefore be of limited use in evaluating downstream impacts. It could however be useful at the field scale for the evaluation of upstream processes. In constructing large-scale budgets, total P was considered the most robust measure and the minimum requirement. The logistics and cost of bulk sampling programmes also negate the widespread adoption of recent sampling techniques, which could be used to identify different P forms.

The website contains detailed summaries of the discussions relating to all the conference themes (http://www.iger.bbsrc.ac.uk/igerweb/NWNew/IPTW/IPTW2001.htm) and a book containing selected contributions to the workshop is to be published.

Russell Smith
Environmental Water Resources Engineering
Imperial College London

President's piece

The last three months have passed quickly: either it is old age creeping up or I must be having fun!

More seriously, what has happened between the main committee meetings in October and January? Early in November I attended the launch of the ICE Commission report, "Learning to live with rivers", and its formal presentation to DEFRA Minister, **Elliot Morley**. If you haven't read the report I recommend it to anyone with an interest in floods and flooding. It is on the ICE web-site at www/ice.org.uk/. The press comment was limited, and tried to sensationalise some aspects of the findings. In so doing it ignored the "meat" of the document. The Minister promised to respond to the report and it will be interesting to hear the government's views on some of the recommendations. It provides another opportunity for further changes in the way we respond to flooding problems, and builds on the extensive progress the Environment Agency has made since Easter 1998 in managing flood defence and in its complete overhaul of the flood warning service.

I attended the Royal Society meeting "Flood risk in a changing climate" in November, and I congratulate **Howard Wheater** on his considerable input to its planning and for making the meeting attractive to a very wide range of disciplines and interests. The papers will be published by the Royal Society later this year and they should be read by flood professionals. The meeting was oversubscribed, and the

full attendance and diversity of the participants resulted in lively discussion and exchanges that would not have taken place in meetings attended by hydrologists or engineers alone.

Steven Wade, who chairs our Internet subcommittee, is seeking volunteers to join the committee and assist him in planning and supervising the redevelopment of the web site. Hands-on computer skills are not required and no programming will be involved: this will be contracted out. This is an opportunity to influence and participate in BHS's further move into electronic communications, serving you the members and promoting BHS through its **www.hydrology.org.uk** web address. If you think you could help, please contact Steven at sdwade@wsatkins.co.uk.

There have been some changes on the committee. **Samantha Green** has been a conscientious and hard working representative for the South West Section, contributing to that section's revival, but felt unable to continue in that role because of new responsibilities in her job. However, she will remain on the committee and continue to represent younger BHS members. **Paul Bates**, from the Geography Department at Bristol University, who has been co-opted onto the main committee, will take over as the South West Section representative.

The Society has always given a high priority to encouraging its younger members, and I reported in the last issue on the success of the Post-graduate Symposium. Your committee has now decided to launch an annual student prize: this follows a suggestion from **Dawei Han**, who drew our attention to the availability of similar prizes for engineering and geography. Copies of the circulars sent out to appropriate departments are enclosed: please pass one on to anyone (student or lecturer) who you know may be interested to ensure we give the prize maximum publicity.

The BHS Research Strategy was published in 1994 and the Committee has decided that it is now time to revisit and update it. I am very grateful to **Alan Werritty** who has offered to lead a group of members to undertake this. If you wish to make a submission for consideration by the group on the direction that UK hydrological research should take in the next 10 years, please e-mail Alan (a.werritty@dundee.ac.uk). This should be no more than a side of A4 and must be received by *31 March*.

Details of the meetings planned until the autumn appear on the back page. The FEH meeting in March is one of the few occasions, other than the Symposia, when we have issued an open invitation for potential speakers to submit abstracts. We were pleased to receive more than enough for a full day meeting, but this has meant that **Peter Spencer** had to refuse some offers, simply because the day was not long enough, and he has tried to achieve a balanced content for the meeting.

As always, we rely upon the voluntary efforts of members, both as organisers and as speakers. Every effort is made to keep costs down so that charges should never deter members or their employers from supporting the Society's meetings. A consequence of tight budgeting is that we need to know how many people will attend a meeting in order to arrange catering at least a week in advance. If we don't, we have to guess the number and are charged for uneaten lunches, thereby incurring a loss. The alternative (which will apply in future) is that lunch and refreshments will not be available for late bookings. Therefore please respect the booking deadline and get your form in by post or email to Tim Fuller before it. In short, a late booking *might* mean the meeting is fully booked, but it will now *always* mean ***no lunch***!

Planning for the 8th National Hydrological Symposium is now moving into top gear: by the time you read this the committee will be busy reviewing abstracts. The overall theme, *"Water Extremes & Water Stress: Science, Policy and Practice"*, has been developed into some interesting sessions: outlines and key speakers are in the enclosed circular. In the last *Circulation*, I said that as hydrologists we have a responsibility to look beyond the science and fully take into account sociological interactions and implications and to influence the development of policies and procedures. If you haven't yet made a note of the Symposium dates (8-11 September 2002), now is the time to put them in your diary.

Peter D Walsh
walshpeter@cs.com

Climate change and snow

Scottish Hydrological Group meeting
University of Stirling
24 October 2001

***John Harrison*'s talk was based on the findings of a project carried out for the Scottish Executive by Stirling University, in association with Mountain Environments, as part of the Executive's research into climate change.**

In setting the scene John referred to the IPCC report of 10% reduction in snow cover, observed during the period 1973 to 1994 across the Northern Hemisphere. He backed this up by referring to studies in the USA, Canada, Europe, and even Australia where either snow cover or depth had noticeably decreased in recent decades. These observations appear to be consistent with trends projected by some climate change snow studies. For example a 2°C temperature rise in Switzerland during the 21st century has been predicted, which would reduce the area of ski snowfields by 63%. Other projections suggest that the snowline will rise, on average, by 52 m per decade for the worst-case scenario. John, however, felt that most studies were somewhat crude, based upon large-scale climate change projections, and that these did not help at the local scale: in some instances they would give quite the wrong impression.

It was in this context that the Scottish Executive had commissioned the study in Scotland.

The objectives were:

(i) to describe recent changes in Scottish snow cover,
(ii) to examine the socio-economic effects of such changes,
(iii) to project changing patterns of snow cover over Scotland for the 21st century (based on UKCIP98 climate change data), and
(iv) to assess how such changes might affect Scotland.

The detail of the study was constrained by the limited amount of systematically recorded snow data. The record of the number of days with snow lying, collated by Met Office observers, provided the best source of long-term data for the project. Other sources were the Met Office's "Snow Survey of Great Britain" publications and data, local observations by organisations such as ski companies, and satellite imagery dating from the 1970s onwards.

Given these data, the study focused on investigating trends in Scottish snow cover. Averaging information from five long-term days-with-snow-lying stations, showed that snow cover

has been quite variable during the 20th century. No long-term trend could be identified however snow cover had noticeably decreased from the late 1970s to present. John went on to show, from the analysis of 36 such stations for the period 1961-1990, that a strong linear relationship existed between the mean number of snow days and the mean Scottish winter temperature anomaly (nine snow days lost on average per 1°C increase in mean winter temperature).

The chosen approach to projecting snow cover in the future was to use temporal analogues from the historic record that matched the UKCIP98 projected winter temperature and precipitation conditions for Scotland. The scenarios used were the Medium-Low and Medium-High, and it proved possible to find analogues for the 2020s, 2050s, and 2080s from the historic record. From the analogue data, linear relationships were fitted to latitude and longitude and a more complex function was used to model the relationship with altitude. This enabled the mapping of projected snow cover over the whole of Scotland to a scale of 1km^2, together with changes from the baseline period of 1961-1990. In general terms this suggested that the greatest reductions will occur in the more northerly regions (number of snow-lying-days per winter reduced by 25-28 days by the 2080s), whilst the snow conditions on higher mountains are likely to be less affected.

John's research was used to calculate changes for each regional authority. This suggested that Fife would have the greatest proportional reduction in snow cover (up to a 74% reduction by 2080s for a Medium High Scenario) whilst the Central Region would be less affected (up to a 46% reduction by the 2080s). This might be useful information to the roads departments, and possibly to flood hydrologists and flood managers.

As part of the study they sent questionnaires, together with their projections, out to people in Scotland with an interest in snow conditions, in an attempt to establish the likely impact of projected snow conditions. As well as the obvious concerns from the ski industry (and many from other non-water-related sectors) the following hydrological issues were raised:

- Potential future need to re-assess design snow conditions for reservoir flood studies;
- Potential change in magnitude, frequency and seasonality of floods;
- Management of water resources may become more or less complex with increasingly transient snow packs;
- Flood forecasting and water resource management will require better information about real-time snow cover and melt conditions;
- Resulting changes to flow regimes may affect sediment movement, river habitats and fisheries.

John finished by emphasising that their work was all based on the UKCIP98 scenarios, which came with inherent uncertainties, and that one should not discount: (1) the complicating influence of meteorological features, such as the North Atlantic Oscillation, which plays an important role in determining the prevailing weather types, and (2) the potential for non-linear change, such as changes to the North Atlantic Drift, which could have drastic impacts upon the Scottish climate.

Richard Gosling (Dundee University) asked why the lower altitudes showed a greater variability in snow cover days. **Dick Tabony** (Met Office) described it as being the area of transitory cover as opposed to the tops, where temperatures were sufficiently low to keep the snow. **David Price** (Babtie Group) asked if the imminent UKCIP02 scenarios would provide information that would greatly improve the snow projections. John felt that they would mainly improve the spatial resolution aspects.

Andrew Black (Dundee University) wondered what useful and practical snow monitoring could be done in the future. In response, **Dick Johnson** (Mountain Environments) outlined the transitory nature of Scottish snow, which did not lend itself to methods deployed in countries where more permanent packs develop. In the Scottish context no major steps forward had been achieved, despite several decades of trying, and no automated network yet existed.

Kate Heal (Edinburgh University) asked whether remote sensing might be the answer. John believed that there was sufficient resolution to estimate the volume, but it was not yet possible to estimate the density, which is key to the determination of water equivalent. Andrew Black said that the discussion had highlighted a need to tackle the monitoring of snow afresh.

Alistair Cargill (SEPA) wondered if the findings of the study might need to be taken into consideration when applying the Water Framework Directive, since they suggest the possibility of changing flow regimes. He added that a decreasing average snow cover may not necessarily result in a decreasing risk of major snow melt floods — since projections of increasing winter precipitation might result in heavier snow falls coupled with increasingly conducive snow melt conditions.

Finally Kate Heal asked if there were potential to validate John's snow model on climatically similar regions such as western Norway, where more detailed snow records existed. John thought that this would make a useful study in itself.

Dick Johnson thanked John on behalf of the Group for his time and effort in presenting such a clear and interesting talk.

David Price
Babtie Group, Glasgow

Changing wetlands conference: new developments in wetland science

Sheffield University
11-13 September 2001

Helen Gavin's report on selected papers in the session 'Hydrological and biogeochemical dynamics' complements Joseph Holden's personal report from the same conference in the last issue (*Circulation 71*, pp 11-12).

Geert van Wirdum (Netherlands Institute of Applied Geoscience) gave an entertaining talk on a robust instrument called 'Prickstock' for monitoring temperature and electrical conductivity. The probe can be used to generate profiles of these variables to a depth of 5 m and data were presented from peat wetlands: these results were used to illustrate seasonal patterns, preferential flow paths and mixing of water sources. **Kate Barber** (Cranfield

University) spoke about her doctoral research into the impact of water and aeration status upon nutrient status and how they influence the distribution of vegetation in wet grassland environments. **David Gowing** (Open University) presented different methods by which the water regime can be interpreted to explain the presence or absence of plant species within a wetland, using data from different types of wet grass-land.

Only two papers detailed evaporation fluxes, both using data from wetlands in Kent. **Helen Gavin** (University of Manchester) presented an operational method for computing actual evaporation loss from wet grassland. Results were referenced against data from the Bowen Ratio Energy Balance (BREB) approach, and the Priestly Taylor approach was found to be the optimum method using coefficients relating to the surface inundation of the wetland surface.

Catherine Peacock (University of Cranfield) also used the BREB approach to assess its feasibility to determine actual evaporation loss from a reedbed wetland. For both papers the reason for using the BREB approach was its accuracy, but while it was suited to the wet grassland environment, the conditions in reedbed environments posed problems for the functioning of the instrument, resulting in careful data screening and some periods with no data.

Rob Bryant (University of Sheffield) gave a very interesting talk on using remote sensing to illustrate the spatial and temporal coverage of *Sphagnum spp.* in wetlands. *Sphagnum spp.* can be used to indicate hydrological conditions, for example the position of the water table. Samples were taken and dried in the laboratory. Spectral measurements were taken at 12-day intervals during the drying phase with a handheld spectrometer, using the same wavelengths as three satellites: Landsat Thematic Mapper (TM), Enhanced TM, and SPOT. The results showed a clear association of spectral response with moisture changes. The best wavelength corresponded to Landsat ETM bands 4 and 5. There are some disadvantages with the technique: the spatial resolution of remotely sensed images generates averages over areas of ~30 m (Landsat ETM pixel size). Also some *Sphagnum spp.* have a highly variable spectral response to changing wetness, while others show less response. However, the results were promising, showing that remotely sensed images, through the spectral response of *Sphagnum spp,* could be used to infer hydrological conditions over time for large areas, or those with difficult access.

Dr Helen Gavin
School of Geography, University of Manchester

New members

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

Dr Margaretta Ayoung	British Waterways, Watford
Dr William H Blake	University of Wales, Swansea
Katherine R Bullock	W S Atkins, Cheshire
Richard Carpenter	University of Exeter
Joanne Cullen	Environment Agency, Bangor
Chris Dunlop	Binnie, Black & Veatch, Surrey
Joanne Emery	University of Birmingham
Dr Philip Fermor	Middlemarsh Environmental, Kenilworth
Dr Jonathan W Finch	CEH Wallingford
Christopher Green	Entec UK, Newcastle upon Tyne
Janine Hensman	Edinburgh
Matthew Hill	Montgomery Watson, High Wycombe
Neil M Hunter	University of Bristol
Terry van Kalken	DHI Water & Environment, Shrewsbury
Achilleas Kalopedis	Arup Water Ltd, London
Eva N Mueller	King's College, London
Ali Shaki	Heriot Watt University, Edinburgh
Dr Peter M Stone	W S Atkins, Bristol
Ian L Walton	Weeks Consulting Ltd, Kent
Simon K Whitton	Environment Agency, Wallingford
Daniel Wykeham	Environment Agency, West Sussex

PhD theses

Arctic micrometeorology

Colin Lloyd (CEH Wallingford) has been awarded a PhD by Edinburgh University's Faculty of Science and Engineering, supervised by **Prof. Paul Jarvis FRS** and **Dr John Moncrieff**.

His thesis on *The micrometeorology of a high Arctic site* describes the first combined energy and carbon dioxide study of a polar semi-desert site. This work was based 500 miles from the North Pole at Ny-Ålesund, Svalbard, where NERC has a Research Station.

It provides the extra parameters and insight needed to appreciate more fully the effect of global warming on the Arctic regional energy and carbon dioxide balances, when combined with the more extensive research from the mires, bogs and other more productive tundra regions of the middle and low Arctic. The modelling component extended certain components of the Met Office surface exchange scheme (MOSES) to simulate the unusual water and carbon dioxide exchange processes of mosses and lichens that dominate the Polar semi-desert landscape.

Hydrology of Elmley Marshes

Helen Gavin's PhD research at the Department of Geography, University College London, was sponsored by CEH Wallingford and English Nature. This is an abstract of her thesis entitled *'Hydrology of the Elmley Marshes'*.

Despite the importance of the hydrological regime for the functioning of wetland environments, understanding of hydrological processes, particularly evaporative dynamics and clay soil moisture fluxes, is limited. This original work contributes to further the scientific understanding of wetland systems.

The two lines of investigation are based on field experiments, monitoring of groundwater and ditch water levels and of soil moisture. The first assesses the effectiveness of the Environmentally Sensitive Area (ESA) scheme of the North Kent Marshes to achieve soft moist ground conditions by manipulating ditch water levels. Results show that, due to the clay soil texture and low hydraulic conductivity of the marsh substrate, there is little relationship between the position of ditch water levels and groundwater.

Flooding the marsh surface with brackish ditchwater promotes high surface soil moistures and optimal habitat for waterfowl. However the deleterious effects on soil structure and floristic diversity has to be taken into consideration for the sustainable management of the wetland.

Results prove that the dominant fluxes of water are precipitation and evaporation, so the second investigation focuses on loss of water from the wet grassland by evaporation. First the relationship between surface resistance and soil moisture content is examined, so that 'correct' surface resistance values could be input to the Penman Monteith method to compute actual evaporation according to the wetness of the marsh soil. Results show a complex relationship, with decreasing rates of actual evaporation below

potential rates with soil moisture loss, and a functional relationship has been quantified. Secondly the actual evaporative water loss of the wetland was determined, taking into account the small-scale heterogeneity of surface wetness conditions. The Weighted Penman Monteith (WPM) approach was followed, referencing results against data by the Bowen Ratio Energy Balance method. Results show that the WPM method could be used to compute the actual evaporation loss, but the Priestly-Taylor approach, with suitable values of α, is simpler and equally accurate.

Journal offer

BHS members are offered a preferential rate for the John Wiley international journal *Hydrological Processes*: during 2002, the individual subscription price for BHS members is just *£80* instead of the normal *£1190*.

There is currently a free trial access to the whole of *Hydrological Processes* online, via the Wiley Interscience website, and members who can are encouraged to take this opportunity to view the journal for a short period free.

Hydrological Processes publishes original scientific and technical papers, covering the physical, biogeochemical, mathematical and methodological aspects of hydrological processes, plus research on instrumentation and techniques. It also includes HPToday, a forum for rapid scientific communication of research information sources that deserve rapid dissemination to hydrologists, as well as commentaries, scientific briefings, current awareness, book reviews, listing and reviews of Internet sites, software, conferences and industry updates.

Subscribers simply have to register at the Wiley Interscience site (also free): *http://email.wileyeurope.com/cgi-bin9/flo?y=eIIg0DNkfc0Bbh0BJmG0Aw* and you will then have free access until ***15th March 2002***. Please let the Editor or Celia Kirby know if you would like an extension of this period negotiated.

The committee have also been exploring links with John Wiley & Sons Ltd, in order to pass on details of relevant new publications, to help with our members' professional development.

John Wiley's titles include *Applied fluvial geomorphology for river engineering and management* (Thorne, Hey and Newson), *Global perspectives on river conservation: science, policy and practice* (Boon and Petts), Larry W. Mays' *Water resources engineering*, Brassington's *Field hydrogeology* (2nd edition) and Keith Beven's recent *Rainfall-runoff modelling: the primer*, which was reviewed in *Circulation 69*.

the River Restoration Centre

Working to restore and enhance our rivers

The River Restoration Centre is a national information and advisory centre on all aspects of river restoration, enhancement and sustainable river management. RRC became the successor body to the River Restoration Project in 1998, following the completion of two EU LIFE funded demonstration projects on the River Cole (Oxon/Wilts border) and the River Skerne (Darlington).

We are a non-profit making organisation that provides a focal point for the exchange of information and expertise relating to river restoration and enhancement in the UK. Our primary role is to disseminate information on river restoration and enhancement projects and to provide advice on site-specific technical issues through a network of experienced river restoration practitioners.

To find out more about the River Restoration Centre or how to become a member, please contact the Centre.

River Restoration Centre
Silsoe, Beds
MK45 4DT
tel/fax:01525 863341
http://www.theRRC.co.uk
email: rrc@cranfield.ac.uk

Publications

HSJ contents — special issue

The latest issue of the *Hydrological Sciences Journal* (Vol. **46**, No. 6) is a special issue, entitled "Can science and society avert the world water crisis in the 21st century?" edited by John C. Rodda & Kuniyoshi Takeuchi. It contains the following papers:

Vol. 46 No. 4, September 2001:

John C. Rodda: *Water under pressure*

Irina Krasovskaia, Lars Gottschalk, Nils Roar Sælthun & Hallvard Berg: *Perception of the risk of flooding: the case of the 1995 flood in Norway*

Kuniyoshi Takeuchi: *Increasing vulnerability to extreme floods and societal needs of hydrological forecasting*

Zbigniew W. Kundzewicz: *Water problems of central and eastern Europe — a region in transition*

Pierre Hubert: *Multifractals as a tool to overcome scale problems in hydrology*

Xia Jun & Yongqin David Chen: *Water problems and opportunities in the hydrological sciences in China*

Ashim Das Gupta: *Challenges and opportunities for water resources management in southeast Asia*

Carlos E. M. Tucci: *Some scientific challenges in the development of South America's water resources*

Lekan Oyebande: *Water problems in Africa — how can the sciences help?*

Lars Gottschalk, Stein Beldring, Kolbjörn Engeland, Lena Tallaksen, Nils Roar Sælthun, Sjur Kolberg & Yury Motovilov: *Regional/macro-scale hydrological modelling: a Scandinavian experience*

Taikan Oki, Yasushi Agata, Shinjiro Kanae, Takao Saruhashi, Dawen Yang & Katumi Musiake: *Global assessment of current water resources using total runoff integrating pathways*

Plus book reviews of *Rainfall–Runoff Modelling: The Primer* by Keith J. Beven and *Snow and Glacier Hydrology* by Pratap Singh & Vijay P. Singh.

This volume is available for £28 (IAHS members £14). See the IAHS web site: *http://www.cig.ensmp.fr/~iahs* or order from **Jill Gash**, IAHS Press, CEH Wallingford, Crowmarsh Gifford, Oxon, OX10 8BB, UK *(tel 01491 692442)*.

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IAHS Publication No. 272, *Integrated Water Resources Management* (edited by M. A. Mariño & S. P. Simonovic, ISBN 1 901502 71 6) is also available, price £65, or £48.75 to IAHS members. It contains 61 papers from an international symposium in California in April 2000.

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The latest issue of the *Journal of Hydrology (NZ)* has been received: Volume 40, No. 2 contains a review of Ian Calder's book *"The Blue Revolution"*. We have also received newsletters from the New Zealand and Dutch Societies. Members interested may contact the National Hydro-Sciences Library at CEH Wallingford *(tel 01491 692266)*.

FloodRiskNet

FloodRiskNet is a cross-disciplinary network of excellence that aims to address the problems of flood, dam and coastal erosion risk analysis. It brings together UK academics in engineering, probability and statistics, and environmental science, along with industrial, governmental and professional organisations. The project is funded by EPSRC (the Engineering and Physical Sciences Research Council) and starts on 1 March 2002.

A skeleton web site has been set up at *http://www.cen.bris.ac.uk/FloodRiskNet/* containing a summary of the network aims and methodology and a list of members. A network coordinator is to be appointed, but if you know of anyone who may be interested in getting involved with FloodRiskNet, please put them in touch with **Jim Hall** (Jim.Hall@bristol.ac.uk).

Fellowships

Industry Fellowships are funded by the Royal Society, the Engineering and Physical Sciences Research Council, the Biotechnology and Biological Sciences Research Council and Rolls-Royce plc.

The scheme aims to enhance knowledge transfer in science and technology for those in industry and universities (or similar institutions) to the benefit of UK firms, universities and the individual scientist. It provides opportunities

(i) for academic scientists and engineers to work in an industrial environment and undertake a project at any stage from fundamental science to industrial innovation, and

(ii) for industrial scientists and engineers to undertake research or course-development in an institution of higher education.

Fellows will establish personal and corporate links between the two sectors in the UK as a foundation for their long-term future development.

Applicants can be of any nationality and should be at mid-career stage, with a PhD or equivalent standing in their profession and should hold either an academic post in a UK university or equivalent, or be employed in industry. Research Council institutes are eligible as academic partners.

Awards can be for up to two years full-time equivalent. Part-time fellowships are possible enabling fellows to maintain links with home institutions.

There must be a transfer between industry and an academic institution or vice-versa. The fellow's salary only will be met by the Royal Society: the parent employer continues to pay national insurance and pension contributions. Research expenses may be claimed up to £1500 per year. Approximately eight fellowships are offered each year.

Applications must arrive by 4 p.m. on **7 June 2002**. Application forms and further information are available from the Research Appointments Department, The Royal Society, 6 Carlton House Terrace, London, SW1Y 5AG *(tel 020 7451 2545, fax 020 7451 2543, email ukresearch.appointments@royalsoc.ac.uk, web www.royalsoc.ac.uk).*

News from members

New committee member

Dr Paul Bates has been co-opted onto the BHS Main Committee. Paul is Reader in Hydrology in the School of Geographical Sciences at the University of Bristol *(tel 0117 928 9108, web http://www.bris.ac.uk/).* His research interests include modelling water movement through catchments and river systems, model parameterisation, uncertainty analysis and sediment transport. He is already active in the sub-committee planning national meetings for 2003.

Scottish Water Board appointment

Professor Paul Jowitt, one of the Scottish Hydrological Group's two representatives on the BHS Committee, has been appointed a non-executive member of the Board of Scottish Water.

DEFRA flood defence appointment

Frank Law (BHS President 1997-99) has been appointed by DEFRA until June 2003 to be a member of the Thames Regional Flood Defence Committee.

Meetings

The River Restoration Centre Network Conference 2002
Engineering River Rehabilitation
29–30 April 2002
Stockton on Tees, UK

The RRC's 3rd annual network conference will have the main theme of *'Engineering River Rehabilitation'*. RRC recognises the vital contribution that river engineering plays, alongside hydrology, geomorphology and ecology, in the successful implementation of river restoration projects. This is especially important when sustainable solutions are needed to satisfy the of biodiversity, amenity and fisheries aspirations, as well as meeting critical flood conveyance requirements. This two-day event is a forum for discussion and an opportunity for all interested in river restoration and enhancement to share experiences. There will be two site visits, one of them to the award-winning River Skerne Demonstration Project in Darlington.

The residential cost is £205 (RRC members £175), the day rate is £75 (members £55). For full details please contact **Karen Phillip** *(tel/fax 01525*

Call for papers
International Workshop on VULNERABILITY OF WATER RESOURCES TO ENVIRONMENTAL CHANGE
16–19 September 2002
Beijing, China

Many countries are facing increasing problems in managing water resources. The imperative of sustainable development puts demands on water management. China has many water-related problems, from water shortage to flood protection issues. To manage water resources sustainably, we must identify the vulnerability of water resources to variations in environmental conditions.

From the perspectives of international global change science and leading up to the third World Water Forum in March 2003, this workshop will be a vital regional contribution, and will focus on understanding interactions between the hydrological cycle, the biosphere and land-use change; assessing the vulnerability of water resources to changing environmental conditions, case studies and new challenges.

Papers are invited, particularly case studies from China and other countries including new technical methods. It is planned to publish selected papers in *Hydrological Science Journal* and other international journals after they have been reviewed. Please send abstracts (1000 words) in English, including preliminary results and conclusion, by **31 March 2002** to the address below.

A field trip to the Yellow River will take place before the workshop (10-15 September). The working language is English. Please contact Dr Xia Jun, Hydrology & Water Resources Branch, Institute of Geographical Science & Natural Resources, Anwai, Datun Road, 917 Building,100101, Beijing, P.R.China *(tel/fax +86 10 64856534, email jxia_mail@263.net, xiaj@igsnrr.ac.cn).*

International Conference on the HYDROLOGY OF THE MEDITERRANEAN AND SEMI-ARID REGIONS
Montpellier, France
7–10 April 2003
http://www.mpl.ird.fr/montpellier2003 or fax *+33 4 67 14 90 10* for details

Future BHS national meetings: programme development

The BHS Committee provides a rolling programme of national meetings covering a wide range of topics driven by members' professional interests and current issues in hydrology.

Suggestions of titles or themes for national meetings are welcome at any time. Better still, if you or a group of colleagues wish to organise a national meeting please contact one of the meetings sub-committee (see below) or any other committee member.

Guidance notes on how to plan and hold meetings will be made available, and other assistance can be provided as required. Suggestions for topics that interface with other areas (socio-economics, overseas development, etc.) would be welcome, but we will also continue with mainstream hydrology subjects. Joint meetings with other societies can be arranged, provided that divisions of labour and responsibility are clearly defined and agreed between the parties involved.

Subject to approval by the main committee, the venue, format and content of national meetings are the responsibility of meeting organisers. We aim to spread the national meetings throughout the annual calendar, so their dates should be agreed with the main committee. Ordinary national meetings should provide opportunity for members' participation (e.g. several speakers and discussion from the floor) rather than simply a lecture. It can take about one year to plan a meeting, so now is the time to start thinking about 2003 and beyond.

We hope to hear from you: please contact us soon. With your help we aim to continue to provide BHS Members with an interesting and stimulating programme of national meetings.

Meetings sub-committee:
Ian Littlewood (igl@ceh.ac.uk)
Peter Walsh (Walshpeter@cs.com)
Tim Jolley (Tim.Jolley@sepa.org.uk)
Paul Bates (Paul.Bates@bristol.ac.uk)
Murray Dale (murray.dale@metoffice.com)

Diary

6th March 2002
BHS South East Section (+AGM)
"Sustainable water resources development: a south-east perspective"
Venue: Dept of Civil & Environmental Engineering, Imperial College, London
Time: 14.00 –17.00
Contact: Dr Adrian Butler, Dept of Civil & Environ. Engineering, Imperial College, London SW7 2BU *(Tel 0207 594 6122, Fax 0207 594 6124, email a.butler@ic.ac.uk)*

8th March 2002
"Flood Estimation Handbook – initial experiences (two years on)
Venue: Institution of Civil Engineers, 1 Great George St, London SW1A 3AA
Contact: Peter Spencer *(tel 01925 653999, fax 01925 415961, email peter.spencer@environment-agency.gov.uk)*

13th March 2002
Scottish Hydrological Group
"Use of GIS for inventory of standing waters" and "Water quality and ecological conditions of Scottish Lochs"
Venue: University of Edinburgh
Time: 18.30 *(tea at 18.00)*
Contact: Dr Kate Heal, University of Edinburgh *(tel 0131 650 5420, fax 0131 662 0478, email kate.heal@ed.ac.uk)*

18th -22nd March 2002
UNESCO IHP FRIEND Conference
"Bridging the gap between research and practice", Cape Town, South Africa *(tel +27 46 6224014, fax +27 46 6229427, email FRIEND@iwr.ru.ac.za, web http//www.ru.ac.za/institutes/iwr)*

20th March 2002
Welsh Hydrological Group
"The geotechnical expert witness"
Venue: Cardiff University
Time: 17.30 for 18.15
Contact: Tim Arkell *(tel 01873 852572, email tim.arkell@environment-agency.gov.uk)*

5th April 2002
Scottish Hydrological Group
"Movement of pollutants into groundwater from agriculture" (4 papers)
Venue: Kinross, Time: 13.00
Contact: Dr Kate Heal *(see above)*

23rd April 2002
BHS National one-day meeting
"Climate change and hydrology"
Venue: Institution of Civil Engineers
Contact: Steven Wade, WS Atkins *(tel 01372 754260, email sdwade@wsatkins.co.uk)*

22nd-26th April 2002
European Geophysical Society (EGS) XXVII General Assembly
Venue: Nice, France
Contact: EGS Office, Max-Planck-Str 13, 37191 Katlenburg-Lindau, Germany *(tel +49 5556 1440, fax +49 5556 4709, email egs@copernicus.org, web http://www.copernicus.org/EGS/)*

8th May 2002
BHS Midlands Section
"River bed patches: hydraulics, ecology and geomorphology"
Venue: Loughborough University
Contact: Steve Rice *(tel 01509 222748 fax 01509 223930, email s.rice@lboro.ac.uk)*

15th May 2002
BHS South East Section
"Floods and SUDS!"
Venue: Institution of Civil Engineers
Time: 18.00 for 18.30
Contact: Dr Adrian Butler *(see above)*

1st-5th July 2002
Fifth International Conference on Hydroinformatics
Venue: Cardiff School of Engineering, Cardiff University, Cardiff, Wales, UK
Contact: Cherrie Summers *(tel/fax 029 2087 4421, email SummersC@cardiff.ac.uk, web http://www.cf.ac.uk/engin/news/confs/hydro/index.html)*

8th–10th July 2002
3rd Inter-Celtic Colloquium
"Celtic water in a European framework: pointing the way to quality"
Venue: Nat. Univ. of Ireland, Galway
Contact: Conleth Cunnane *(tel 00 91 750425, fax 00 91 524913, email conleth.cunnane@nuigalway.ie)*

18th July 2002
BHS National meeting
"Networks and monitoring"
Venue: ICE, London
Time: 2.00 p.m.
Contact: Steve Parsons, Mott MacDonald Ltd, Demeter House, Station Road, Cambridge, CB1 2RS *(tel 01223 463926, email sbp@mm-camb. mottmac.com).*

2nd–6th September 2002
Conference on "Quantitative precipitation forecasting"
Venue: Reading University
Contact: Kevin Tilford, WS Atkins Ltd, Birchwood, Warrington WA3 7WA *(tel 01925 622051, fax 01925 622054, email ktilford@wsatkins.co.uk)*

8th–11th September 2002
BHS 8th National Symposium
"Water extremes & water stress: science, policy & practice" — including ***Postgraduate Symposium & AGM***
Venue: University of Birmingham
Contact: Sue Lane *(tel 0121 414 7455, fax 0121 414 5528, email lanes@is-fs10.bham.ac.uk)*

16th October 2002
BHS National meeting + Roy. Met. Soc.
"Meteorology and Hydrology — towards closer collaboration"
Venue: ICE, London Time: 2.00 p.m.
Contact: Murray Dale *(tel 01344 854896, fax 01344 854156, email murray.dale@meto.gov.uk)*