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Circulation

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- Membership enquiries: Richard Howard, Institution of Civil Engineers, 1-7 Great George Street, London SW1P 3AA. *Tel 0171 665 2234, E-mail howard_r@ice.org.uk.*
- Editor: John Griffin, Institute of Hydrology, Wallingford, OX10 8BB. *Tel 01491 692427. Fax 01491 692424. E-mail b.h.s@ua.nwl.ac.uk.*
- Internet: http://www.salford.ac.uk/civils/BHS

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The Exeter Statement

"Hydrology in a changing environment" was the first international conference run by BHS. The three-volume set of published papers is available from John Wiley & Sons. BHS *Occasional Paper No. 9*, containing poster papers and the index, is available from Jenny Reddaway at Salford University. The *Exeter Statement*, reproduced here, will be presented to the Inter-Government Conference on Hydrology in Geneva next year.

Context of the Exeter Statement

Experts and the public are both more troubled than ever before about both the future for water management and the protection of environmental systems. In response to that situation, the International Conference on Hydrology in a Changing Environment drew 250 attendees from 70 nations to consider 164 papers on key themes of the UNESCO International Hydrology Programme and the WMO Hydrology and Water Resources Programme.

The six conference themes over the week from 6-10 July were a reminder of those concerns:

- Global hydrological processes
- Ecological & hydrological interactions
- Groundwater at risk
- Hydrology of environmental hazards
- Catchment management and resource assessment in dry areas
- Hydrology of large cities

The Conference recognised that hydrologists are being asked to work on a wider canvas. Integrated or holistic management of river basins is involving ever larger contacts with other stakeholders to examine the environmental significance of the various hydrological pathways, rivers being the most obvious.

Interaction with economists, lawyers, conservation and community groups, consumer interests, industry managers, navigation bodies and many more is known to be necessary. The dilemma is whether the legitimate need to improve hydrological science, and to disseminate its results, will get lost in a 'democracy' of other concerns. The need to improve hydrological understanding in depth, and to reduce the uncertainty of its predictions, could become marginalised whereas it should be the cornerstone of effective basin management.

Research success in the field of global hydrological processes (ongoing since the 1982 IAHS Assembly at Exeter) has contributed to motivating international agreements on climate change. It is known that

- Water is the primary greenhouse gas;
- The fate of increased water in the atmosphere is the primary cause of uncertainty in climate change predictions;
- Input by hydrologists of observations, process understanding and sub-models has contributed to improving the credibility of General Circulation Models;
- Calibrated coupled models of surface energy and water balance for vegetation prone to change has facilitated predictions of likely alterations in regional and global climate.

Hydro-ecology has come of age in the last decade, with physical habitat simulation modelling in wide use for policy setting. The interplay of biology with hydrology is a major theme for the new millennium.

Numerous case studies from all continents had demonstrated to attendees that success could be achieved in specific projects to master long-running environmental or resource scarcity problems.

The organisers of the Exeter Conference sought primarily to give those present (many of them senior figures in hydrology in their home countries) an opportunity to identify leading issues and critical opportunities which should:

- Drive national and continental research in the new millennium;
- Assist the Fifth Joint UNESCO/WMO Inter-Governmental Conference on Hydrology, set for 8-12 February, 1999 in Geneva, to make useful progress in cooperative activity.

Key ideas from themed discussions

These often had much in common and hence are given jointly here:

- Better catchment management is often hindered in much of the world by hydrometric records that are too short to capture the variability against which society now seeks protection and timely warning. This is particularly obvious in arid areas, but our changing environment makes the urgency for sustaining long index records far more general than that.
- We need to communicate our extensive experience, while continuing to listen to those needing it. Dialogue must be:
  - between people within our discipline and outside it;
  - between specialists and water managers
  - between specialists in and newcomers to hydrology
  - between specialists and the public.

  Meanwhile the transfer of educational knowledge must be sustained.
- We recommend that consideration be given to a Second International Hydrological Decade as a major project within the current framework of activities of UNESCO , WMO and others. It would recognise the existing world observation programmes in related sciences, and be targeted at providing those comprehensive datasets and interpretative science needed to lower the uncertainty in hydrological prediction in areas of environmental, economic and social importance. It could build upon time series, for the 2001-2011 period, of variables as diverse as
  - global surface moisture
  - continental soil-vegetation-atmospheric transfers
  - digital water tables of regional aquifers
  - city water input, loss and effluent time series
- Over-used resources threaten many people and often only partial solutions have been found; alternatives to conventional water supply and waste disposal are still needed for some countries.
- Society will benefit by hydrologists demonstrating effective operational rules based on models that incorporate predictive uncertainty in all elements.
- Professionals must strike a balance of effort between modelling and field data collection, as poor models threaten professional credibility.
- Forecasts are only as useful as the ability of the audience to interpret them.
- Progress will be helped by freer data exchange; but it is recognised that some regions have no records and others have them for short time spans that could be unrepresentative.

Ideas more specific to each theme

Those ideas held with conviction are:

Global hydrological processes

- There is a need for a better understanding of long-term and global scale patterns and processes to aid the production of seasonal and regional scale forecasts;
- Land/atmosphere/ocean coupled models need to be developed further, and extended to include to water quality and ecology problems;
- More physically based methods for downscaling global predictions to local conditions need to be developed.

Ecological and hydrological interactions

- The need is for multi-disciplinary teams, unfettered by the limits of the original education of the different scientists; hydrologists venturing into ecology in isolation will have difficulties;
- Research should range over scales including catchment, river reach and microhabitat levels, in environmental zones from headwaters to river mouths;
- Similar research projects will be required in different areas where biotic species assemblages exhibit clear differences;
- Biodiversity protection requires our contribution, with advancement from simpler interpretations to the more complex unsolved mysteries;
- River bed flux research is a promising new field.

Groundwater at risk

- The 4-dimensional environment demands fundamental process understanding, directed now towards recharge and unsaturated zone processes, and aquifer / stream water interactions;
- Recharge estimation is held back for lack of a satisfactory way of measuring bulk vertical conductivity;
- Planners and the public should be urged to support the control of aquifer use, implemented by strong institutions.

Hydrology of environmental hazards

- Our ultimate concern is to reduce the likelihood of disasters, concentrating on reducing vulnerability both by works, land zoning and early warning systems;
- Weather hazards feed through to ecological systems in ways not well understood;
- Greater integration of hydrological and climatological aspects of hazards should be featured, along with uncertainty;
- Constraints to use of hydrological warning systems are often social or economic;
- Models of landslides, as an example phenomenon, did not often have calibration data.

Catchment management and resource assessment in dry areas

- Quantifying the high variability in

time and space of hydrological variables, including sediment loads and flood transmission losses
- Understanding the interactions between:
  - ephemeral flows and alluvial groundwater,
  - shallow and deeper groundwaters,
  - land use, sediment generation and surface storage management,
  - scale dependence of runoff and channel transmission losses;
- The profession needs to draft, in conjunction with other competent institutional bodies, enforcement measures to control and protect water resources in arid areas; this will need to be done locally, using best practice from other related areas.

Hydrology of large cities
- Urgent needs exist for integrated systems modelling and management, focused on interactions of components;
- Regulations related to city hydrology have been promulgated (with good intent) ahead of the scientific and technical capability to deliver a quantified solution in many cases, e.g. water quality monitoring;
- Both active (hands-on) high technology and passive (non-structural) approaches are desirable; post-implementation maintenance cannot be neglected;
- Transplanting either of the above approaches to cities in developing nations must be questioned;
- Radical rethinking is warranted for wastewater separation at source, with recycling of greywater for other uses.

Conclusion

After revision by plenary discussion, the conference attendees adopted this Exeter Statement by acclamation at their final session, and asked that the British Hydrological Society put it forward, through the UK Government, to the organisers of the 1999 Inter-Governmental Conference on Hydrology in Geneva.

Global hydrological processes at Exeter

Theme one at Exeter 1998, 'Global hydrological processes', was most appropriately subtitled 'Improved hydrological representations'.

In an excellent keynote address on the 'Future of hydrology in large-scale models', **Keith Beven** (Lancaster University) raised some potentially controversial ideas, asking whether an aggregation theory is possible through small-scale theory to large-scale problems. A host of problems confronts us in any attempt to model the large-scale environment from our limited understanding of small-scale processes. One problem was that many processes are unobservable, and of the observable processes the scale of observation may not be at the scale we are interested in. Through our uncertain environment we use likelihoods to map landscape space into model space. But we also face equifinality, with many models and parameters being acceptable for modelling. We seek generalities from the uniqueness of place and through process complexity, and Keith suggested that aggregation is impossible when the extremes of distributions may be the most important. Scale-dependent modelling may be the way forward.

Jim Shuttleworth (University of Arizona) gave an excellent keynote address, at the start of the second day, on the recent interest in the El Niño phenomenon and the impacts of the El Niño Southern Oscillation (ENSO) around the world. There are seasonal fluctuations in the Southern Oscillation Index (SOI), but Jim showed how there may be longer term fluctuations, with variations in the strength of ENSO over time. Perhaps events such as the Asian monsoon may be predictable from these longer time scale variations. Jim also discussed Global climate change impacts briefly, and hypothesised that at the catchment and regional scale, statistics of hydrological behaviour are related to hydrometeorological variables, which may be changing over time. He left us with some thought-provoking ideas to support the establishment of a second International Hydrological Decade.

One of the strengths of the Exeter conference was that delegates came from nearly 70 countries: case studies presented in this theme were from the central USA, Scotland, the French Alps, Turkey, Slovakia, Australia, Nigeria, the Netherlands, China, Estonia, Southeast Asia, North America, Central Asia, the Rhine and Elbe basins, south-west India and Croatia; a couple of larger scale studies included many sites across Europe. Many papers dealt with the aggregation and disaggregation of information. Discussion included upscaling, modelling of small scale processes up to the continental scale, to downscaling output from GCMs to the local scale. The application of models at different scales became an issue and several papers presented models that have been applied at the catchment scale but which have the potential to be applied at a larger scale. However, **Sarah Dunn** pointed out that different processes may dominate at a larger scale (e.g. routing), which are not represented in the model applied at the smaller scale. Model inputs need to be simplified too, so as to handle large areas. **Geoff Kite** explained how he had applied three different models at different scales in Turkey.

The modelling approaches presented varied from physically-based to semi-distributed and distributed models, and included a weather-conditioned Markov model. These models have been applied from the catchment scale to the regional scale, for a wide variety of applications: to aid water scarcity problems, flood management and design flood, groundwater modelling, through to a great deal of hydrological impact modelling (e.g. modelling the impacts of climate change on runoff and peak flows and estimating changes in future water resources). Other applications included statistical downscaling of time series, for example disaggregating monthly to daily runoff, and downscaling GCM output to local scale statistics, such as rainfall forecasts.

Ian Cordery presented a very interesting paper on forecasting precipitation from atmospheric circulation and SOI. Ian has computed some fascinating partitioned correlations between precipitation, SOI and geopotential heights. He has found very high correlations between these variables, up to coefficients of 0.9, for an area greater than the size of England. Very high lagged correlations also exist in the system at three-month and six-month lags, with relationships evident even at lags of twelve months. Ian is now striving for a physical explanation of these very strong correlations and lagged relationships in the system, which seem to provide good prospects for three- to six-month forecasts for large parts of Australia.

Problems flagged up during the presentations included the model representation of extremes: it is easy to see why society requires extremes to be modelled correctly. Robust model paramaterisation is a problem and human influence, such as water abstractions, introduce additional problems and can cause observed values to differ from those modelled. Models are highly constrained by data availability: in fact problems associated with data — the lack of it and its quality — were a focus in discussions during the conference. Geoff Kite pointed out how the type of model developed and applied depends not entirely on the application, but also on the data available. It is essential to make optimal use of the data available, and the use of remotely sensed informa-

tion seems to be increasing. Recently the Internet has become a great source of data, but we must be wary of its quality, as its origin is often unknown. Computing power, particularly with physically-based approaches, also introduces constraints to modelling. However the continued technological explosion that is changing our science will also increase our modelling capabilities.

Discussions during these two days provided some very interesting ideas for future research. There seemed to be a need for improved spatial representation of processes in models and the development and careful testing of spatially distributed models. The use of coupled ocean-atmosphere-land models also seems to be a key way in which to progress. Forecasting and estimating the impacts of climate change provided some interesting disparities in the time-scales of predictions. Accurate forecasting of variables on a seasonal basis is an important focus for future research, but operations such as reservoir projects need predictions on much longer time-scales. However, uncertainty tends to lead to forecasting by estimates of probabilities and likelihoods rather than precise quantification. Ian Cordery mentioned the fragile credibility of forecasters and how the media can get hold of, interpret and present forecast information (and not always correctly).

We learned a great deal at the conference and one particularly interesting point that came up a number of times was the need to understand variability — including inter-annual and intra-annual variability — as much as change. We also need a strong dialogue between scientists of different disciplines and with engineers applying the science. One thing that is apparent is that we work within, and must deal with, a framework of uncertainty.

I wish to thank the Society for assisting me financially to attend this excellent conference. With help from BHS I was able to present some of the findings from my postgraduate research to a large international audience, and I met so many interesting people from all over the world. Exeter 1998 was a great experience.

Caroline Shorthouse
Department of Geography,
University of Southampton

FSR rainfall-runoff debate: David Archer's reply

2 Welburn Close, Ovingham
Northumberland, NE42 6BD

2 August 1998

Dear John,

Although you headed **Max Beran**'s response in *Circulation No. 58* to my note on the Flood Studies rainfall runoff method 'final', I hope — in view of the forthrightness of Max's remarks — that you will allow me one further brief reply.

Max devotes much of his response to refuting an assertion which I did not make, namely that the return period of rainfall and resulting flood must be equivalent. I agree that this is neither realistic in the real world nor necessary in the modelled world.

Both Max and **Mike Lowing** in *Circulation No. 57* also appear to believe that I was making comparisons only between the rainfall runoff method and the simpler FSR statistical method, which I agree would be inappropriate. As a hydrological practitioner, the basis of my note was the observation of a systematic spatial bias in flood growth by the rainfall runoff method compared with observed flood frequency distributions. Over large areas of upland Britain (and elsewhere) more than 90% of observed flood growths are flatter than the rainfall runoff equivalent. I used the statistical growth curves for comparison only because (in spite of being based on short records) they still provide a closer match to average flood growth within their regions (as currently defined).

The inspection of residuals is both a respectable and a necessary statistical practice. As **Jim Dooge** remarked at the recent Exeter conference, "You only know how something works when you know when it doesn't". Essentially I have found that FSR rainfall growth is higher than observed flood growth and, given that there is no counteracting means of suppressing growth, the modelled growth rate for discharge is inevitably too high in some locations. As currently formulated the method is not sufficiently flexible and requires revision.

The inspection of residuals is not sniping. I had assumed that we were aiming at the same target, though as a victim of Max's fusillade, I suspect that I have been on the opposite side of the proverbial Irish firing squad — formed up in a circle!

Yours sincerely,

David Archer

Tel & Fax 01661 834063
e-mail: archerd@jba-ne.demon.co.uk

Response to hydroecology article

20 October 1998

Dear John

We welcome *Circulation* highlighting issues linking hydrology and river ecology, such as the article on *'Current trends in river water quality modelling'* (*No. 57*, March 1998, p. 11), reporting on a BHS meeting presentation by **Prof. Paul Whitehead**. We feel that some misinterpretations have been reported, which have clouded important points that should be debated and researched. Specifically:

- Incorrect statements about the fundamentals of PHABSIM (Physical Habitat Simulation System);
- Incorrect statements about the Axford Inquiry;
- Misrepresentations about PHABSIM which reflect strengths, not weaknesses of the model;
- Issues being attributed to PHABSIM, but which actually relate to a much wider policy context.

We offer the following comments in order to improve understanding of the strengths and weaknesses of the PHABSIM model and the IFIM (Instream Flow Incremental Methodology) approach.

Like any model, PHABSIM has its strengths and weaknesses: many of the criticisms currently being levelled at the method are due to misunderstandings. It is essential that both the application and further development of PHABSIM are based on informed debate.

PHABSIM

The following statements are incorrect; we offer our comments alongside each (quotes from the original article are in italics):

a *"This empirical model was developed ... with the aim of explaining habitat changes from medium to long-term variations in flow"*. PHABSIM can equally be applied to flow changes on an hourly to yearly basis: a key driving force in its development was assessment of hydropower impacts.

b *"The main assumption in the model is that the quality of habitat is a surrogate for fish population in the river"*. There is no such assumption in the model. In river systems, physical, chemical and biological factors influence fish populations. Changes in river flow regime change the in-river physical environment.

c *"The curves indicate the probability of encountering a particular fish under particular flow conditions"*. They indicate suitability, to target species, of individual physical variables (such as

depth or velocity) or combinations.

d *"based on friction coefficients that have to be assumed"*. Model calibration parameters are in fact estimated from field data.

e The terms *'habitat'* and *'preference curves'* have been misused in the *Circulation* report.

The Axford Public Inquiry

a *"The Axford Inquiry ... was exclusively based on the application of the PHABSIM model"*. The Inquiry included discussion of a whole range of issues, not least the economics of water resource development and of the valuation of the water remaining in the River Kennet. Only 26 of the 143 pages of the Inspector's final report discussed PHABSIM issues.

b The issue of the habitat suitability indices (discussed at the BHS meeting). The expert opinion of Dr Hardy (providing expert evidence for the Environment Agency) and Dr Payne (for Thames Water Utilities Ltd.) both confirmed that it was common to transfer habitat suitability indices between similar rivers. The Inspector agreed with their expert advice (report page 130-131).

c The issue surrounding the PHABSIM representative reaches selected. The expert witnesses at the inquiry confirmed that it was not common to model rare habitat types. Experience in other studies has shown that riffle habitat is particularly sensitive to reductions in flow. The Inspector was satisfied that the sites chosen on the Kennet represented the river adequately (Inspector's report p. 127).

Strengths, not weaknesses

The following statements represent strengths, not weaknesses of the modelling approach:

a *"the weighted useable area habitat curves depend on the life stage"*. It is an advantage to have a model that represents the differing requirements of the life stages that occur in nature.

b *"The hydraulic models use a non-linear function for the stage discharge relationship"*. The stage/discharge relationships used in PHABSIM may be linear or non-linear to reflect the characteristics of the site in question.

c *"the weighted useable area habitat parameter is very sensitive to different hydraulic models"*. A range of hydraulic model types and simulation options are available in PHABSIM. The objective is to use these tools to maximise the accuracy of the simulated hydraulic conditions in the study reach prior to the simulation of the available physical habitat.

Issues with a context much broader than PHABSIM

a *The issue of collaboration between stakeholders* is not a PHABSIM issue *per se*. Clearly it is advantageous if the organisations involved in any in-stream flow dispute can collaborate, negotiate and agree. However, this is rarely achievable through all stages of this kind of assessment and it is more likely that dispute will occur sooner or later. This is certainly the case in the USA where fully collaborative negotiations appear to be the exception rather than the rule.

b *The issue of the 10% habitat reduction.* Ideally, selection of critical levels has to be a political decision, and does not reflect a limitation in any particular model. However, in the Axford case, the figure was not *arbitrarily selected*, but specifically chosen to reflect known uncertainty in the modelling: habitat losses of less than 10% were discounted to reflect this.

Model sensitivity is an important issue and it is correct that it should be given a high priority. The PHABSIM User Forum has been established to facilitate collaboration between active users and researchers, members are addressing the issues of habitat model sensitivity and the transfer of suitability criteria.

Finally, we would implore commentators to separate clearly the technical and political issues surrounding application of river models.

Yours sincerely,

Mike Dunbar
(Hydro-ecology Group, Institute of Hydrology)
Craig Elliott
(formerly a member of the same group)

Reference

McPherson, J.I., Appeal by Thames Water Utilities Limited: Axford Abstraction. Water Resources Act, 1991. Environment Agency.

(The views expressed are ours, not necessarily those of our respective employers.)

BHS AGM

University of Birmingham
17 September 1998

The BHS Annual General Meeting took place in the midst of the National Meeting on *Flood Storage*, held jointly with the West Midlands Branch of CIWEM (see report on page 7).

Apologies for absence

Apologies were received from Howard Wheater, Steve Parsons, Allan Lambert, Peter Walsh; Sue Walker, John Griffin, Peter Stern, John Thornes, Mike Lowing, Chris Soulsby and Mike Acreman.

President's introduction

Frank Law introduced the meeting and drew attention to the increased requirements imposed on the Society by the Charities Act. The information pack summarised the Society's activities over the past year, as well as the usual accounts.

Hon. Secretary's report

It is my privilege to give you a report of the Society's activities over the last 12 months: so here is my view! I said it last year (but I am sure it remains true) that we continue to organise the best, and certainly the cheapest technical meetings in hydrology on a wide range of topics.

Our first-ever International Conference was held at Exeter University in July. This event was considered to be a resounding success. 250 delegates of 70 nationalities attended — an astonishing 20% were professors! We heard a wide variety of papers and contributed to some very stimulating discussions. I would like to thank all those who took part, particularly the local organising committee. Another "first" was the publication of the Exeter proceedings by John Wiley & Sons: special thanks are due to the reviewers, and to Celia Kirby and her team at IH who put in Herculean efforts. The results certainly look very smart on the shelf, matched by the quality of the actual papers. However I'm sure I can't have been the only delegate in the registration queue who was dismayed at the extra weight I had to take home with me! There were some who felt they were too expensive — we would welcome any views to consider in future. Exeter provided very congenial surroundings, and I felt significantly fitter at the end of the week after going up and down the hill between the conference centre and my accommodation. Jim Dooge's keynote address has been posted on the web, to give it a wider audience. The meeting also

produced an "Exeter Statement", which is currently (I hope) wending its way along the corridors of power to establish BHS as an influential voice on the world scale, and to promote the idea of a 2nd International Hydrological Decade, from 2001 to 2011.

Over the last year, water resources have been in the news in the UK: this was reflected in two National meetings, one in March on the recent Surface Water Yield Review, and a further one in July on groundwater yields. The March meeting pioneered a new format, with most of the afternoon given over to open discussion. This proved very successful, and gave a larger number of members from all sides of our profession the opportunity to contribute in an open and lively manner. This format is also being used here today, and I hope this will continue. Last October we also held an Ecohydrology Workshop in Sheffield — again this is a topic of great current interest to members.

The annual Postgraduate symposium was held in Birmingham: this continues to be a successful formula. We hope that those taking part will find it a useful stepping-stone into hydrology, and that they will become long-term members of the Society!

Regional groups wax and wane to some extent according to the availability of keen individuals. Their efforts are essential to the health of the Society and are made despite the universal increase in workload which we all seem to have to cope with. One of the unfortunate effects is that things get put off until the last minute, and therefore events are more difficult to organise and publicise effectively. I recognise that I have been a notable offender in this respect! All members can contribute by putting up with administrative hiccups, coming to meetings, making their views known constructively, and doing whatever they can to further both hydrology and BHS.

Cooperation with other societies continues: the October meeting was held jointly with the British Ecological Society; the groundwater meeting was with the Geological Society. The joint meeting with the Challenger Society on the LOIS project has had to be postponed to 25th September.

Other National meetings planned for the next 12 months include a day on the infamous Easter floods, a technical visit to the Thames Barrier, the annual post-graduate symposium, and meetings on managed rivers and processes. We are also supporting or jointly organising a water resources meeting with CIWEM, a climate change meeting with the ICE Water Board, and the International Symposium *Uplands 1999* next April. The IUGG Assembly in Birmingham in July 1999 is also a very important event for the Society, so our next biennial symposium has been delayed until autumn 2000.

Programmes of regional meetings are also well in hand, with a variety of British and overseas topics.

The Main Committee has held its usual quarterly meetings, but we have been experimenting with later starting times to make it easier for members to attend — and to benefit from cheaper fares. Hopefully this will encourage more nominations in future! I would like to thank all the committee members for their attendance and contributions over the last 12 months. I particularly want to thank **Mike Acreman** and **Bob Sargent**, who are retiring from the Committee, for all their work.

This is also one of my last duties (or should I say pleasures!) as the BHS Hon. Secretary. As I was previously on the Committee as an ordinary member, it will be strange *not* to be attending the next quarterly meeting. Many people have commented that the Hon. Secretary's task is an onerous one: all I can say is that I have had lots of support from other people throughout, notably **Richard Howard** at ICE and both Frank and Terry, the other officers, and their predecessors. I think my skin is thicker after many phone calls along the lines: "I am ringing on behalf of the British Hydrological Society, and I appreciate you are very busy, but would you be willing to consider ... ?". Thanks to all of you who said yes! I also firmly believe that I have had at least as much from BHS as I have contributed, in terms of personal and professional contacts.

I would now like to formally welcome the new members of the Committee. I am personally delighted that **Peter Walsh** has agreed to take over from me as Hon. Secretary, and wish him well. I hope he doesn't find my filing too incomprehensible!

In taking on this role he leaves a gap which is being filled by Steve Parsons, who has (much to my relief) also taken on the task of completing the Hydrologists Tool Box. He tells me that we still need contributors to the sections on sediment transport and soil erosion, so please contact him if you feel able to contribute, or know someone who might be persuaded.

We also welcome **Dawei Han** from Bristol University, and **Matthew Lees** from Imperial College, London, who is already managing the BHS Web site. Each of them will bring a valuable influx of fresh ideas.

Last, but most certainly not least, we are very pleased that **Howard Wheater** has agreed to become President-Elect, continuing his long involvement with the Society.

In conclusion, therefore, I am confident that the Society continues in good hands, and will continue to offer the rest of us a varied and interesting menu over the next few years.

Honorary Treasurer's Report

Terry Evans began by informing the meeting that the latest membership figures stood at 757, compared with 734 at the same time last year.

He explained that the accounts were submitted in two formats, each with a report: the longer one was included to comply with the Charity Commission's requirements, whilst the other followed the traditional form, and the Hon. Treasurer presented the latter. Terry Evans explained that for convenience balances were held in three accounts: a General Reserve Fund, a Symposium Reserve and the Exeter Fund. In the past year the reserves had increased in each fund and the total reserve now stood at £84436, compared with £67258 last year. The finances were therefore in a very healthy position, and as a result, membership fees would not increase this year. Because of the large reserve, the number of travel awards had been increased and a review of the procedures for administering the Exeter Fund was being undertaken. Although the increase in reserves was partly due to good housekeeping, members were warned that in the main it resulted from high capital growth and high interest rates, which were unlikely to continue in future years.

Mike Hamlin emphasised the special nature of the Exeter Fund and the way it was set up for attendance at IAHS conferences: it should remain for that purpose only. He was reassured that the Hon. Treasurer had no intention of changing the basis of the fund, only exploring ways in which it could better be used within the existing framework.

Rod Hawnt was concerned about the increasing reserves, and asked whether the Committee should consider having free meetings. His attention was drawn to the current policy for members to pay for the refreshments, the intention being to balance the books. It is difficult to predict attendance in advance.

Frank Law proposed acceptance and Hilary Smithers seconded. The accounts were approved unanimously.

Report of *Circulation* editor

John Griffin was not present, so this report was presented by Celia Kirby.

Since the last AGM in Salford there have been three issues of *Circulation*: *No. 56* (November 1997; 20 pp, including a summary of the 6th Symposium, the text of the Penman lecture and a list of the new committee), *No. 57* (March 1998, 16 pp) and *No. 58* (June 1998, 10 pp).

For the first time, these issues have also featured on the BHS worldwide web pages at http://www.salford.ac.uk/civils/BHS/BHS_Circulation.html.

Only the front page is displayed, in a portable document format that enables it to be read on the screen or printed out in its correct format, but with some added colour.

There is now a contents list on the front of *Circulation*, which I hope gives enough of a flavour to persuade some Internet-surfers to subscribe to the full printed newsletter.

I would like to thank Matthew Lees and Kevin Tilford for their work on the web pages, and all contributors to *Circulation*, including Frank Law for his President's Piece, Hilary Smithers and others for diary dates, Richard Howard for the list of new members and everyone who has offered meeting reports and other articles.

There has been plenty of lively comment following David Archer's provocative article on the FSR rainfall-runoff method. David will have the last word in the forthcoming issue, but it has been suggested that the BHS mailbase could be used to carry on this sort of debate in the future.

Celia and John have been recovering from the mammoth task of editing the Exeter conference volumes. *Circulation 59* is due to appear in October, carrying some further views from Exeter and reports from the AGM. News from individual members and about activities in the regions are always welcome, including figures and photographs. Although these will only be printed in black, anything that makes it onto the front page can be shown in full colour on the web!

Any other business

There was no other business.

Join the BHS email news list

There are now 147 on the mailbase list sponsored by BHS, so if you have email why not join it? Do not worry that you will be flooded with messages: they only average one per week, so it isn't a chat shop. Rather it permits us to share something quickly (such as a meeting change) or to pass on news that is ephemeral. Naturally there will be the occasional matter of real substance, which is by nature unpredictable.

You can join by sending an email to **bhs-hydrology-request@mailbase.ac.uk**, saying in the body of the message **join bhs-hydrology** *your name.*

There is no need to put anything in the subject box of your email. Fuller details of the mailbase are at **http://www.mailbase.ac.uk**

Thereafter you can address everyone on the list by emailing **bhs-hydrology@mailbase.ac.uk**

You can check who will be receiving your message by sending an email to **mailbase@mailbase.ac.uk** , with the body of the message being simply **review bhs-hydrology**

It is so simple: why not give it a try?

Frank Law

Flood storage: current practice and problems

BHS National Meeting
University of Birmingham
17 September 1998

The meeting was jointly organised with the West Midlands branch of CIWEM. *Dr Paul Webster* (School of Civil Engineering, University of Birmingham) began by setting the scene and highlighting some possible flood storage concerns.

The first paper, "Storage in sewers and tanks — a cost-effective approach to urban drainage for the new millennium?", was given by **Professor Bob Andoh** (Hydro International plc). He described two types of solution for flooding that resulted from rapid urbanisation and consequent increases in impermeable surfaces. The first solution, the *'old paradigm'*, is reactive/curative, conveying the peak flows away from urban areas as quickly as possible. The alternative approach, the *'new paradigm'*, is pro-active and preventative by catching water early.

Bob suggested that costly traditional 'end of pipe' solutions are the result of the old paradigm. He explained that adopting nature's way of resolving urban drainage could make considerable cost savings. Before urbanisation, nature used vegetation to attenuate rainfall runoff, encouraged evapotranspiration and slowly recharged groundwater by percolation: in essence this is a spatially distributed flow attenuation system. Adopting nature's way of effecting controls at an early stage means reducing/attenuating flows into and through urban areas before they arrive at problem areas, so that pipe upgrades and the need for larger capacity ancillary components can be avoided. Figure 1 illustrates the benefit of upstream control of the flood peak.

Bob suggested that flows could be managed and controlled by disconnecting downspouts from roofs, infiltration and local storage, passive flow regulation devices and supplementary distributive storage. Two case studies described the application of this approach in real catchments: Wandley Road, Waltham Forest and Columbus Water Works, Georgia. They illustrated the scope for cost savings of around 50% over traditional interceptor schemes.

The main factors that have prevented widespread adoption of distributed systems were tradition and institutional issues. Engineers have been trained to think along the lines of traditional concepts, but designing sewers to convey peak flows and the institutional arrangements in most countries are not compatible.

Bob concluded that we should move towards more preventive approaches and let nature teach us.

The second paper, "Case studies from the Birmingham area" by **David Gordon** (Severn Trent Water) outlined flood storage methods used by Severn Trent. They are to spend £250 million in the period 1995 to 2000 to resolve flooding problems, which therefore need to be cost effective. David discussed three case studies, ranging in cost from £593K to £2817K. These were Allerton Lane, involving two concrete tanks *in situ*, Smethwick Hall Pool, involving an oversized pipe and box culvert and Brasshouse Lane Overflows which involved the construction of a segmental ring shaft. They illustrated that the best solutions require the engineer to consider all available options. The advance in hydraulic modelling tools is aiding analysis and design, giving greater confidence in the final solution.

David Pettifer (Jeremy Benn Associates) gave the third paper, "Design considerations for flood storage reservoirs and ponds", co-written by **Alison Williams**. He discussed design concepts, methods, types of control and software tools used: the most comprehensive design guide for flood storage was CIRIA Book 14 – *The Design of Flood Storage Reservoirs*.

The combined effect of the multitude of flood balancing areas now being constructed in some catchments could actually increase peak flows downstream. This was illustrated by the River Blythe catchment in Warwickshire. The results of a case study showed that for the 1:100 year event, the peak flows on the tributaries had decreased. However, peak flows in the River Blythe

immediately downstream of each tributary confluence had increased: this was due to the timing of the peak flows and the extended duration of the resultant hydrographs. David concluded by recommending that catchment-wide modelling should be undertaken to show all the effects of flood storage, and the design capacity of storage ponds and reservoirs should take account of the downstream capacity of the receiving watercourses.

Professor Bryan Ellis (Middlesex University) gave the final paper, "Water quality and flood storage systems". He explained that the primary functions of a storage systems are public safety and the protection of downstream areas. However, secondary benefits can include water quality improvements, conservation and additional land use. He highlighted water quality problems that may arise with the first flush of a system.

Bryan explained that the target objective of water quality control is very different to flood control. To improve water quality, initial flow volumes associated with storms with a recurrence interval of 0.25 to 0.5 year need to be captured and contained for as long as possible. He stressed that there is a lot of scatter on detention basin performance and it is very difficult to predict removal characteristics from the design. However, the removal capacity can be considerably enhanced if the basin is fitted with a vegetative wetland.

The afternoon session, chaired by **Brian Faulkner** (Integrated Water Management) started with four short presentations on current problems and practicalities.

Roy Ladhams (Environment Agency) discussed the problems of new development. The Agency could only advise planners and their authority was limited. Provided that a developer shows that there is no increase in discharge, then the Agency are unable to object. However, development control is the most important aspect of flood defence.

Clive Wright (Birmingham City Council) then discussed the problems and practicalities of flood storage for a land drainage authority. He discussed three approaches to flood storage/ balancing: detention tanks, open attenuation and detention storage. He stated that a balanced approach is required and there is rarely an easy answer to scheme selection.

The third presentation by **David Cope** (J J Gallaghers) gave a developers perspective on flood control. He discussed the difficulties in meeting the Agency guidelines on best management practice. A major problem is who will adopt the maintenance of storage facilities.

John Packman (Institute of Hydrology) discussed large-scale modelling techniques used to investigate the effects of ponds on a catchment of over 50 km^2. He used FSR unit hydrograph techniques for the sub-catchments and the Muskingham-Cunge routing method.

Discussion

After each presentation there was a short interval for questions. This was a good chance to stimulate thoughts for the main discussion later on. **David Hall** asked Bob Andoh about the idea of using rainwater from house roofs and how it could be utilised without the need for hand pumping equipment. The reply was that a change in attitude was required to encourage people to harness the resources available, but failing that, pumps could be used.

Cliff Dobson (Environment Agency) asked David Gordon about the design criteria adopted for flood storage systems at Severn Trent Water. David said that generally 1:5 year critical duration storms were selected and a 'value for money approach' was required. **Mike Barker** (Sandwell M.B.C.) took the opportunity to stress the importance of computer-based modelling techniques and referenced software such as Hydroworks for use in urban drainage design.

Frank Law (IH) commented on the interesting effect discussed in David Pettifer's presentation where online storage in tributaries can actually increase the potential flood levels in larger rivers, because of the timing of flow peaks. It was agreed that understanding a catchment's response to rainfall was crucial.

Before tea there was a forum for discussion prompted by the earlier sessions. This focused on a wide range of topics, including the Agency's policy on maintaining flood defence schemes, water quality benefits gained by the selection and sizing of flood ponds, the developers' viewpoint on urban drainage schemes for housing developments and the results of a modelling study on flood storage ponds in the Bracknell area.

In particular, **John Turner** (Leeds City Council) commented on the importance of using design flow data in modelling work. John Packman's work had focused on historic events and he agreed that further research on the study was required.

Cliff Dobson commented on the many conflicts of interest concerning the selection of flood storage schemes: a common policy implemented by a single body was necessary. This invoked various comments: the consensus seemed to be that better local development plans would be of use and perhaps the technical knowledge available within BHS or CIWEM could be used to introduce better legislation on urban drainage strategy. **John Stowell** added that engineers could perhaps also have an impact on legislation through the ICE. The buck is often passed between institutions and it was agreed that a single authority could perhaps provide a framework for urban drainage design. Frequently, good sites for flood ponds get built on. Again, the importance of adequate flood modelling work was stressed.

Paul Webster concluded by thanking everyone for their contributions. He said that the BHS and its committee could play an active part in developing better guidelines for flood storage schemes and he hoped that this matter would be taken further.

Overall this was an interesting meeting, with an abundance of constructive, learned comments and opinions voiced, enhanced by the diverse backgrounds and experience of those present.

Emma Blunden & Tom Saville
Halcrow Group Limited

Members on the move

Richard Boak has moved to Shrewsbury to be UK operations manager for Water Management Consultants Ltd, an international group specialising in water resources and supply, mining hydrology and water-related environmental issues. The UK team is particularly strong in groundwater modelling and hydrogeological problem solving.

The BHS Southern Section is sorry to lose him, but Richard has lost no time in joining the Midlands Section Committee. Tel: 01743 231793, Fax: 01743 232894.

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Kate Heal has recently moved from the University of Stirling to the Institute of Ecology & Resource Management at the University of Edinburgh. Her address is: Dr Kate Heal, Institute of Ecology & Resource Management, The University of Edinburgh, Darwin Building, Mayfield Road, Edinburgh EH9 3JU. She can be contacted on Tel: 0131 650 5420, Fax: 0131 662 0478, Email: Kate.Heal@ed.ac.uk.

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Past President **Dr Mike Lowing** and his wife have moved home and office south-westwards along the Ridgeway from Brightwell Baldwin, Oxfordshire to Providence Farm, Common Water Lane, Broadwindsor, Beaminster, Dorset DT8 3QR, Tel: 01308 867228, Fax: 01308 867238, email (unchanged) mike_lowing @compuserve.com. The river rising there (grid reference ST445028) is one of the headwaters of the River Axe.

Mike will continue to run Chiltern Digitising Services and to function as a Director of Water Resource Associates (www.watres.com).

President's piece

The Environment Agency is to be commended for its openness with the publication of the Bye Report on the Easter floods. The summary of its findings can be perused at http://www.environment-agency.gov.uk under the heading Environment Information if you have web access; otherwise "hard copy" can be obtained through the Bristol Headquarters Press Office.

Naturally my eye was caught by the implications for hydrologists. Here are just two of them from the findings section of Volume 1:

- "Further problematic issues concern the scarcity of senior staff with advanced academic training and qualifications in hydrology, open channel hydraulics and computational hydrologic and hydraulic modelling."

- "Hydrometric standards should be enhanced to ensure that the siting of flow measuring and telemetry equipment is above likely extreme (0.5% annual probability — 200 years return period) flood levels."

I am convinced that these and many other recommendations will result in a growth in the number of hydrologists working in the flood mitigation field. However, it is noticeable in the excellent coverage of the arrival of the report in the EA newsletter, Environment Action, for October/November 1998 that all the changes that result from implementing the Bye Report will have to be achieved by switching budgets from other headings. It is sad that at this stage the Government does not seem to have been sympathetic to finding new money to enhance the public desire for higher standards of flood warning and defence security.

In the section that summarises the experience at Leamington, I noted the paragraph which said "The number of properties that flooded in the morning of 10th April 1998 is assessed by the Agency as approximately 400. Most appear to date from the early 1900s or before. Although the Agency had no knowledge of the majority having flooded previously, it seems that extreme but somewhat less severe floods occurred in 1900, 1920, 1932, 1939 and 1947."

It is to try and lessen the surprise at the breaking of previous flood records that we in the Society have launched the hydrochronology web pages (http://www.dundee.ac.uk /geography/cbhe/). This is already populated with over 900 entries and we hope that members will find it not only a valuable resource but wish to add to it so its strength gets better and better.

I was delighted to attend the Welsh Hydrological Group meeting and AGM on September 8th at Cardiff University. Steve Taylor (Environment Agency, Wales) gave a very good presentation on "Flood warning in south-east Wales". The extension of flood warning activity by automatic telephone techniques is clearly extending the ability of hydrologists to forewarn the community of concern but brings with it considerable responsibilities to keep the very extensive underlying databases right up to date.

Attention for some will now be turning to the IAHS meetings in Birmingham next July. I do hope that many of you will be identifying one or possibly both weeks to be present to meet the many international hydrologists who will be coming for the multi-streamed event, and that plenty of UK papers will properly represent the state of our science to the world. For its part, your Committee has sanctioned a proposal to produce a special Occasional Paper for that event which will summarise the state of hydrological research in this country at the end of the millennium by giving an A4 page to each and every group of hydrological researchers in this country to display their achievements. If you would like to know more, then Celia Kirby is acting as its Editor.

Frank M. Law

Latest documents received from UNESCO

Available for loan from the IH Library (telephone 01491 692266) are the following documents received by the UK IHP Committee:

Water, the city and urban planning, International Hydrological Programme, Symposium Proceedings 10-11 April 1997 UNESCO Paris (SC-98/WS/8).

Premier atelier scientifique du projet FRIEND AOC, (Cotonou, Benin, 14 decembre 1995), Variabilité climatique et variabilité des ressources en eau, Programme hydrologique international, PHI-IV Projet H-5-5/PHI-V Projet 1-1, PHI-V Documents Techniques en Hydrologie No 16, UNESCO Paris 1997 (SC-98/WS/10).

Use of fuzzy logic to encode archival climate research uncertainty, Lucien Duckstein, A contribution to the UNESCO ARCHISS Project, IHP-V Project 1.4, IHP-V Technical Documents in Hydrology No17, UNESCO Paris 1998 (SC-98/WS/22)

Water: a looming crisis? Proc. internat. conf. on World Water Resources at the Beginning of the 21st Century (UNESCO, Paris, 3-6 June 1998) ed. H. Zebidi, International Hydrologyical Programme, IHP-IV Project M-1-3, IHP-V Technical Documents in Hydrology No 18, (SC-98/WS/21)

World water resources: a new appraisal and assessment for the 21st Century, a summary of the monograph 'World Water Resources' prepared in the framework of the International Hydrological Programme by Igor A. Shiklomanov, Director, State Hydrological Institute St Petersburg, Russia, UNESCO 1998.

See also under "Books" on page 14.

IH grows

Building work has now begun at the Institute of Hydrology to construct a new conference room, headquarters offices for CEH and a new office wing.

Visitors may also be pleased to know that the library will get improved facilities and the restaurant is being enlarged.



East African events analysed

Unusually heavy and prolonged rain together with extreme floods occurred in many parts of East Africa over the period November 1997 to May 1998. During a recent visit to Tanzania, working on drainage design for the railway, I needed an evaluation of these unusual rainfalls. To my astonishment, I found nothing of any such sort had been attempted. I made a rapid sampling of the data, particularly as it affected the railway around Dar es Salaam, Dodoma, Tabora and Mwanza. Also some available records from other parts of Tanzania were also collected to broaden the picture.

Daily rainfalls recorded at 23 locations during the period September 1997 to May 1998 were acquired for the analysis, more than half of the data being only available from the regional centres. Tabulated below are the greatest rainfalls recorded at nine locations for 1-day, 10-day and 40-day periods, evaluated using log-normal statistical parameters for these same locations derived during previous investigations of flood risk from 379 station-years of daily records. The 1- to 40-day maximum rainfalls for all 23 locations were also compared with expectations: these and other details are not given here for lack of space but can be supplied by the author.

The rainfalls experienced and the resultant floods include many events which, from a consideration of past records, can be considered extremely unlikely to occur again. Indeed some of the individual records would be hard to accept if they had occurred in isolation, as the institutional arrangements, underfunded for more than two decades, leave much to be desired. However, the widespread occurrence and the severe flooding provide corroboration. The largest river in Tanzania, the Rufiji, was estimated to have been discharging 10 000 $m^3 s^{-1}$ for more than a month. The 21 years flow record for 1960-1980 indicates a 100-year return period flood of 8000 $m^3 s^{-1}$. The recent flood has an estimated return period exceeding 500 years.

From the sample of 23 stations for which daily rainfalls were acquired, 17 had rainfall events with return periods of above 10 years. Of these, nine include events with return periods exceeding 100 years. The more detailed analysis of the eight selected stations tabulated below show three locations with events with return periods estimated to exceed 1000 years.

These rainfalls and floods were considered locally to be El Niño/ Southern Oscillation (ENSO) events. In the literature such rainfall events in Africa are called teleconnections to ENSO events. Perhaps these extreme events will provide researchers with extra information to test hypotheses to clarify something useful about the coupling mechanisms. I would also welcome a geographical appraisal: these exceptional rainfalls, together with flooding such as had never been seen in a lifetime, were widely accepted without much surprise or comment. Many dwellings were swamped, roads were impassable, the central railway ground to a halt for eight months but, when asked, no-one had a figure for the costs of flood damage, although it was said that the rice crop had been unusually good. Such small responses to such extreme events would surely repay study.

Jasper Tomlinson
185 New Kent Road, London SE1 4AG
Tel/fax 0171 357 9457

Table 1 *Comparison of n-day rainfalls for eight sites in Tanzania. Expected mean, 10-year & 100-year annual maximum n-day rainfalls (mm). Logarithmic means and standard deviations (SD) are shown in italics.*

	$_{24h}p_m$	$_{24h}p_{10}$	$_{24h}p_{100}$	$_{10d}p_m$	$_{10d}p_{10}$	$_{10d}p_{100}$	$_{40d}p_m$	$_{40d}p_{10}$	$_{40d}p_{100}$
Mwanza	88.9	145.8	218.7	174.2	259.6	360.7	368.0	518.9	688.2
(as logn)	*4.488*	*SD: 0.381*		*5.160*	*SD: 0.308*		*5.908*	*SD: 0.265*	
Same	70.1	105.1	146.5	120.6	185.7	264.1	220.8	351.1	510.1
(as logn)	*4.250*	*SD: 0.312*		*4.792*	*SD: 0.332*		*5.397*	*SD: 0.355*	
Lushoto	66.4	98.3	136.1	164.0	242.7	336.2	343.3	470.3	604.2
(as logn)	*4.196*	*SD: 0.304*		*5.100*	*SD: 0.304*		*5.839*	*SD: 0.240*	
Tanga	115.3	185.6	275.6	246.7	412.1	629.2	452.0	736.7	1102.8
(as logn)	*4.748*	*SD: 0.369*		*5.508*	*SD: 0.397*		*6.114*	*SD: 0.378*	
Tabora	75.3	103.2	134.0	157.4	207.7	261.2	362.2	467.2	575.9
(as logn)	*4.321*	*SD: 0.244*		*5.059*	*SD: 0.215*		*5.892*	*SD: 0.196*	
Dodoma	71.1	96.7	125.1	145.0	201.6	262.5	269.5	396.1	541.6
(as logn)	*4.264*	*SD: 0.240*		*4.977*	*SD: 0.251*		*5.596*	*SD: 0.296*	
Dsm	80.9	115.7	156.1	196.6	281.1	375.5	407.7	566.8	738.0
(as logn)	*4.393*	*SD: 0.279*		*5.281*	*SD: 0.274*		*6.011*	*SD: 0.251*	
Chunya	72.3	110.6	156.2	182.2	262.4	353.5	381.7	568.8	790.2
(as logn)	*4.281*	*SD: 0.326*		*5.205*	*SD: 0.281*		*5.945*	*SD: 0.308*	
Mbeya	56.4	71.6	86.9	145.5	203.7	267.7	344.6	454.9	572.0
(as logn)	*4.032*	*SD: 0.183*		*4.980*	*SD: 0.258*		*5.842*	*SD: 0.215*	

Table 2 *n-day maxima computed from the recorded daily rainfalls for 1997-98*

	$_{1d}p$	$_{24h}p$	K_T	T(y)	$_{10d}p$	K_T	T(y)	$_{40d}p$	K_T	T(y)
Mwanza 9232009	**194**	**219**	**2.33**	**100**	313	1.90	35	548	1.50	15
Same 8437003	88	99	1.12	8	179	1.19	9	392	1.62	19
Lushoto 9438003	**167**	**189**	**3.43**	**›1000**	**469**	**3.45**	**›1000**	**828**	**3.68**	**»1000**
Tanga 9539015	190	215	1.68	22	601	2.24	80	941	1.94	38
Tabora 9532012	67	76	0.02	2	248	2.12	59	498	1.62	19
Dodoma 9635001	107	121	2.22	75	**355**	**3.56**	**»1000**	528	2.27	87
Dsm 9639029	85	96	0.62	4	285	1.35	11	520	0.97	6
Mbeya 9833001	**191**	**216**	**7.34**	**»»1000**	**279**	**2.52**	**170**	**692**	**2.97**	**671**

Notes:

i) Unusual events where T ≥100 are in **bold** type.

ii) p is rainfall (mm) where the subscript indicates the period of duration of the maximum rainfall event: e.g. $_{10d}p$ is rainfall for ten consecutive days.

iii) The records for Mwanza' have been revised to include an (under-) estimate for the storm rainfall of 10/5/98 which swamped the meteorological instrument site.

iv) K_T is Chow's frequency factor assuming log-normal distribution where T is the return period in years.

v) The first four digits of a station number indicate the degree square.

Radar hydrology for real-time flood forecasting

Advanced study workshop
University of Bristol
24 June to 3 July 1998

This advanced study course brought together recent graduates and researchers in the fields of hydrology and meteorology. It aimed to develop an understanding of radar hydrology and its operational use for flood forecasting and to encourage multidisciplinary discussion of the topic. The workshop was funded by the Commission for the European Communities under its Environment and Climate Programme and it was organised by the Water Management Research Centre at the University of Bristol. The course contained formal lectures in the mornings and interactive workshops in the afternoons: 37 students of 11 nationalities attended.

The opening day was devoted to an overview of radar meteorology and real-time flood forecasting, with students having the opportunity to operate radar-processing software in the workshops. **Prof. Ian Cluckie** (University of Bristol) discussed the importance of radar hydrology in operational flood forecasting, which is reflected in the Environment Agency part funding of the UK radar network and development of regional flood forecasting models. **Prof. Geoff Austin** (University of Auckland, New Zealand) continued the introductory theme by discussing the history of radar from its early development during the Second World War to the realisation that it could be used to detect rainfall echoes. This was conceived, in part, by the efforts of Marshall and Palmer in relating radar reflectivity Z, *directly* to rainfall rate *R*.

Prof. Austin opened the second day with a discussion on weather radar theory and practice. In supporting radar rainfall detection Prof. Austin emphasised that hydrologists in general hold too much confidence in sparse areal networks of raingauges and showed that errors in hydrological application of radar data depend on errors in the radar calibration. **Dr Jean-Dominique Creutin** (Institut National Polytechnique de Grenoble, France) described efforts to minimise errors of beam blockage and bright band detection, which are associated with reduced radar visibility in mountainous areas. **Dr Kevin Tilford** (University of Salford) also presented work on bright band correction using a high resolution vertically pointing x-band radar.

Optimisation of radar data was the theme of the paper by **Dr Marco Monai** (Centro Sperimentale per l'Idrologia e la Meteorologia, Italy), introducing improvements in rainfall measurement offered by techniques such as Doppler radar and dual polarisation. To complete the day's theme, **Bob Moore** (Institute of Hydrology) presented work on real-time radar calibration using raingauge data and gave details of the Institute's HYRAD project.

A paper by **Dr Josep Porra** (Universitat de Barcelona, Spain) on drop size distribution and theory began the third day. Dr Porra demonstrated the ability of weather radars to measure rainfall based on the knowledge of the drop structure of rain, which can be calibrated using disdrometric devices. **Dr Remko Uijlenhoet** (Wageningen Agricultural University, The Netherlands) continued this topic by discussing how the power-law *Z-R* relationship is expressed in terms of the parameters of the raindrop size distribution. **Dr Paul Hardaker** (Meteorological Office, UK) gave an overview of the UK radar network, illustrating the Met. Office's attempts to correct beam attenuation, bright band, ground clutter and anomalous propagation by using the NIMROD system. In the final paper of the day **Dr Paulo Guarnieri** (Fondazione per la Meteorologia Applicata, Italy) presented research on merging radar and raingauge data through artificial neural networks to provide reliable rainfall measurements.

Following the weekend break **Dr Dawei Han** (University of Bristol) opened Monday's topic of rainfall forecasting techniques. He provided an overview of the important role rainfall forecasts have in many operational flood forecasting systems. Often referred to as 'nowcasting', these rainfall forecasting methods include global and local storm tracking and the use of physically based models. Prof. Austin returned to demonstrate the role of satellite imagery in short-range prediction of rainfall with the use of the geostationary GOES, Meteostat and GMS systems in supplementing weather radar images.

Dr Herve Andrieu (Laboratoire Central des Ponts et Chaussées, France) presented work on hydrometeorological modelling based on voluminal radar data made possible by modelling the evolution of rainwater content as observed from volumetric radar data. Prof. Cluckie completed the day's presentations with a brief introduction of the NEXRAD developments in the United States. The Next Generation Weather Radar was illustrated as an integrated Doppler system in the s-band frequency that provides high quality measurements and is designed to supply precipitation estimates for input into hydrological models.

The following day, focus shifted towards application of weather radar for flood forecasting, beginning with a presentation by **Dr Evangelos Baltas** (National Technical University of Athens, Greece). Dr Baltas described the modification of a lumped conceptual model for use in a semi-distributed manner, giving a better representation of spatial variability of storm events. The research also showed that results could be improved by using calibrated radar data rather than raingauge data alone. **Dr Marco Borga** (Universita Degli Studi di Padova, Italy) presented research into real-time correction of mean field bias and range dependent bias in radar data, by identification of the mean vertical reflectivity profile and the use of telemetered raingauges in a combined correction scheme. Dr Han completed the morning by giving delegates an overview of the WRIP (Weather Radar Information Processor) system, a flood forecasting system using Transfer Function models with the facility for real-time updating of parameters.

On Wednesday Dr Baltas continued his theme of the previous day, showing how application of a grid-based distributed model to a mountainous basin in Greece, using processed weather radar data merged with raingauge data as the input, could give better results than a lumped model and raingauge data alone. **Prof. Daniel Sempere Torres** (Universitat Politecnia de Catalunya, Spain) discussed the difficulties of rain-fall runoff modelling in Mediterranean basins, caused particularly by high spatial and temporal variability of rainfall and high intensities. He highlighted the need for radar data to provide the necessary

spatial resolution. **Prof. Geoff Pegram** (University of Natal, South Africa) then presented an overview of developments in radar hydrology in South Africa, concentrating particularly on research into processing of radar data for hydrological applications. In the afternoon, delegates visited the Environment Agency offices in Exeter, where they learned how operational flood forecasting and warning are carried out in south-west England. This was followed by a visit to Lynmouth, scene of a devastating flood in 1952.

The next day began with a talk by **Dr Geoff Shepherd** (Public Services Department, States of Jersey) on the benefits of using radar data in the management of urban flooding. A particular benefit is the ability to track storms in space and time, allowing real time modelling and predictive control of the drainage system. **Dr Hans-Reinhard Verworn** (University of Hanover, Germany) continued the urban theme, discussing the application of a hydrodynamic model on-line and in real-time to an urban hydrological system. This included an optimisation model for decision support. **Dr Peter Walsh** (Consultant in river management and hydrology) provided an overview of the use of weather radar in UK flood warning systems. It was emphasised that flood forecasting is of little benefit without an efficient flood warning system to disseminate the information to those at risk. Prof. Ian Cluckie looked again at real time control of urban drainage systems, discussing a comparison of Transfer Function (TF) and Neural Network (NN) type models and continuing with a description of the RHINOS (**R**eal-time urban **H**ydrological **IN**frastructure and **O**utput modelling **S**trategy) package. An enjoyable course dinner was held in the evening at Ashton Court, an historic building on the outskirts of Bristol.

The final day of the course was for the delegates, who gave group presentations summarising the main themes of the preceding ten days. The topics covered radar technology and data, sources of error in radar measurements, radar measurement adjustment techniques, radar rainfall forecasting and use of radar data in lumped and distributed hydrological forecasting models. In his closing address, Prof. Ian Cluckie thanked the European Community for providing the funding to hold the course and the presenters and delegates for making the course a success.

Michael Cranston (SEPA)
David Lindsay (Environment Agency)

Environment Agency's first national hydrology seminar

Hilton Hotel, Warwick
22 & 23 April 1998

Around 90 employees of the Environment Agency, involved in all aspects of hydrology, attended their first national hydrology seminar. It was organised by the Agency's National Hydrology Group, which was set up at the beginning of 1997 to provide a source of technical expertise and best practice in hydrology within the Agency and to act as a focus for the exchange and dissemination of hydrological information. The varied papers initiated considerable lively debate.

The opening address was given by **Giles Phillips** (Head of Water Resources), who gave an overview of the challenges facing water resources, including convergence, the year 2000 and climate change. He also emphasised the Agency's wish to sell ourselves on good stories, two of them being water resources and the periodic review. He also stated that we need to demonstrate good science and to be open, consistent and innovative in our work.

Professor Geoff Petts (Director of Environmental Research and Management, University of Birmingham) explored hydrological variability as the key issue in setting river flows, as opposed to climate change. He argued that climate is always changing, that human influence on it is limited and that nature adapts to change. In view of this he argued that the key to ensuring sustainable ecosystems is to preserve flow variability. He summed up by saying that we seem to be concerned with protecting small streams, because they show the impact of low flow, yet if we do not protect the large floodplains, certain species will be lost from the larger rivers.

Following on from this topic, **Bob Hillier** (Team Leader – Hydrometry, Brampton) gave a presentation on the R&D project review of overseas approaches to setting river flow objectives (RFOs). These could be categorised into three broad groups: look-up techniques or standard setting, expert panel, and biological response modelling. He concluded that no country had developed a method that was used to the exclusion of all others and that the Agency hoped to use this project to help develop its policy on setting RFOs and that what has been learnt from the project is that RFOs are needed even if only as an outline. This presentation led to much discussion focusing on what targets need to be met and the need for consistency in approach across regions.

In his presentation on the management of the lower Derwent, **Mike Law** (Team Leader – Hydrology, North East Region) described the characteristics of the River Derwent and its conflicting interests of conservation, abstraction for public water supply, fisheries and navigation. He described the progress of a project that has been set up in collaboration with English Nature and Yorkshire Water to identify the best management practices: hydrology had a pivotal role in the project.

Along similar lines, **Bryony Howlett** (Hydrologist, South West Region) gave a talk on the progress to date of the River Tavy low flow alleviation project. Bryony explained the river system and how it is significantly affected by abstraction for hydro-electric power. She described the techniques which have been applied to the study, including fish tracking and PHABSIM and the recently completed flow routing model of the Tavy catchment.

The second of the external speakers was Ian Fox (Head of Hydrology, Scottish Environmental Protection Agency) who gave a talk describing the role of hydrology within SEPA and a general overview of what SEPA's duties are and how it is setup and financed. He explained that one of the main differ-

ence between the Agency and SEPA was that the only statutory duty relating to hydrology which also encompasses hydrometry in Scotland is flood risk assessment, all other functions are non-statutory. This was followed by discussion on the relationship between the Agency and SEPA and how policies are implemented.

Julie Lee Stewart (Hydrologist, Thames Region), gave a presentation entitled *'Hydrologists and decision making'*, looking at the role of the hydrologist in the Agency and going on to discuss the apparent lack of influence to the level needed in business decisions. She suggested that possible reasons for this include a lack of expert power, i.e. the expertise that hydrologists posses is not recognised and a lack of social or personal power as we are that hydrologists are not promoting themselves as well as they could.

Julie then went on to look at what is needed to address this situation, including raising the profile of hydrologists by better use of internal publications, lunchtime seminars, more hydrology R&D and also better use of internal committees such as the national hydrology group and the seminar.

The second day of the seminar kicked off with a talk by **Dr Alan Gustard** (Head of Risks and Resources Division, Institute of Hydrology) discussing current research and the future direction of low flow hydrology. He began by giving a brief rundown of the studies that have been carried out by IH on low flows encompassing natural low flows, automated flow estimation, artificial influences and flow naturalisation. He then went on to discuss the current ongoing studies including the enhancements to Micro Low Flows and looking at historical flow sequences at ungauged sites. He finished off by discussing the proposed direction for future studies involving research into permeable lowlands and drought frequency estimation.

Stuart Homann (Senior Water Resources Planner, North East Region) followed with a presentation on Drought Severity Indices. These were first proposed by the British Hydrological Society in 1994 and have been further developed and implemented in the North East Region. Stuart described how indices are calculated using available data and how these indices can give a more meaningful picture to the industry and the public by defining a drought, its spatial extent and when it ends.

Dr Andrew Baird (Department of Geography, University of Sheffield) in his presentation on wetland hydrology began by giving a definition of what a wetland is and its importance due to its ecological, hydrological and economic value. He explained that there was a lack of understanding of hydrological processes in wetlands, and the difficulties that arise when calculating water balances of wetlands and applying Darcy's Law in groundwater fed wetlands. HE went onto explain that there were few papers available on wetland hydrology and much more research is needed.

Dave Burgess (Groundwater Management, Anglian Region) followed this with a presentation entitled *'Rejected Groundwater Recharge or Surface Runoff'*, describing phase two of the joint Agency and Institute of Hydrology scoping study which follows on from the national research and development project 'Groundwater Recharge Assessment'. Dave explained that the scoping study is aimed at improving estimates of effective rainfall/groundwater recharge and the importance of this to groundwater models, estimating groundwater resources and flow forecasting.

Glenn Watts (Principal Water Resource Planner, Head Office) in his presentation entitled *'Hydrological modelling — where now?'* described the type of models available to the Agency and what key issues should be addressed in modelling studies and he proposed a framework for the application of hydrological models encompassing the specification of computers running models, calibration and validation, the special needs of the Agency in being able to reproduce model results and defend the use of such models and the role of hydrologists in interpreting the data produced.

The last presentation of the day 'Challenging Hydrological Assumptions' was by Brian Greenfield (Principal Hydrologist, Thames Region). He explained that hydrological analysis and studies rely on various basic assumptions which are often built into software making it difficult to determine what is being assumed and the validity of these assumptions. To encourage hydrologists to keep open minds and to be aware of the assumptions made in particular software or models he presented various assumptions commonly used together with alternative interpretations relating to recessions, summer recharge, the effects of riparian zones, relative values of winter/summer rain and runoff from impermeable strata.

The seminar ended with a discussion panel consisting of the speakers and members of the national hydrology group to enable the delegates who wanted to ask further questions of the speakers and to discuss their views of the content and organisation of the seminar. Finally Rob Grew (Chairman of the National Hydrology Group) gave a summary of the seminar and an overview of the future priorities of the National Hydrology Group.

The Group hope to turn the Seminar into an annual event, with the next one planned for eighteen months time.

Lynsay McLean

BOOKS

The UK Groundwater Forum has produced a small, colourful book entitled "Groundwater, our hidden asset", which is informative and authoritative, but readable by a general audience: more detailed reviews and case studies are printed in blue.

Published by the British Geological Survey in their Earthwise series, it costs £6.50 and is available from BGS, Keyworth, Nottingham, NG12 5GG or any bookshop (ISBN 0 85 272304 0).

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A new book on historical hydrology has come to Frank Law's attention:

Hassan, John (1998). *A history of water in modern England and Wales.* Manchester University Press. ISBN 0 7190 4308 5. It includes a bibliography and chapters on:

- The Victorian and Edwardian periods,
- The inter-war and post-war years: the paralysis of special interests,
- A period of optimism, 1951-73: the search for integrated management,
- The Regional Water Authorities, 1973-89: the irresponsibility of government,
- Since 1989: the privatised water industry.

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UNESCO have sent IH a copy of each of the following additions to their series "Studies and reports in hydrology":

54 Crul, R.M.C. (1997) *Limnology and hydrology of Lakes Tangyanika and Malawi*, 111pp.

55 Miloradov, M. and Marjanovic, P. (1998) *Guidelines for water resources assessment*, 120pp.

The UK IHP Committee has received *Water resources assessment, a handbook for review of national capabilities* (WMO/UNESCO) and two UNESCO "Technical documents in hydrology":

1 Mourits, L.J.M. *et al.* (1996) *Proceedings of the Cairo workshops on wadi hydrology and groundwater protection.*

10 IHP-IV project H-1-2 (1997) *Study of erosion, river bed deformation and sediment transport in river basins as related to natural and man-made changes.*

If you wish to borrow any of these books please call the IH Library: tel 01491 692266.

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The *Hydrometric Register and Statistics 1991-1995*, a key reference work covering a very lively hydrological five year period, is now available. Produced by the National River Flow Archive team under **Martin Lees** and **Terry Marsh** (IH), backed by the National Groundwater Archive team under **Andrew McKenzie** (BGS), it gives the latest summary statistics for gauged catchments and boreholes across the

UK. It costs £25 (inc. p & p) and can be ordered from Mrs Jackie Carr, Institute of Hydrology, Wallingford OX10 8BB — cheques payable to the *Institute of Hydrology* please, or to pay by credit card please ring 01491 692252, or we can invoice you if you quote an official order number. The maps were produced digitally this time — no light task, but a route that will smooth the way for successor volumes.

Forgotten flows

I have recently searched the electronic version of the Annual Register which is available on the web for the period 1758- 1778. Among the miscellanea that it contains are occasional descriptions of floods and droughts, many of which were recognised even then as being on a northern European scale. It was particularly striking to come across the first drought marks of which I have heard. Flood plaques, plates and posts are relatively well known, but no British drought mark has yet come my way.

However, the Annual Register tells of a drought mark in the River Neckar on the Rhine that was made on a rock in 1766. At that time, the drought stone revealed by falling river levels had reached four inches below a previous mark of 1476 described as "a memorandum of the drought at that time"!

To my further surprise I find that such a mark is not unique for in the Annual Register for 1774 it describes a report from Altena of November 11th. "It has snowed, and frozen here for eight days past, with a violent wind at East, which has made the water in the Elbe fall lower than has ever been remembered. A large stone was discovered by this means at the bottom of the river, which had been seen 100 years ago, as appeared by a date which was then engraved upon it; and the date of the present year was accordingly engraved upon it, as a proof of the like circumstance".

So at long last we have evidence of, at the very least, useful graffiti. It must be difficult to find sites where drought marks could sensibly be made as presumably it always requires a gorge-like section by a deep pool on a relatively large river. The advent of dredging and the construction of locks for navigation either side of such sites must make them a questionable proposition for the future. Nevertheless it is good to know that our forebears felt driven to record rare droughts, which otherwise we might know even less about.

Frank M. Law
Wallingford

Hydrological Research in the UK 1995-99

Some of you will remember that the Institute of Hydrology used to produce (originally as a contribution to the International Hydrological Decade) a small reference booklet every five years, listing current research projects in the UK.

These have not been issued since 1990, but we intend to catch up by publishing a 1995-99 listing, as a BHS Occasional Paper, in time for the IUGG meeting at Birmingham in July. This brief item is to warn all you researchers that I shall be circulating requests for information in the spring. I'm still thinking about how to tackle this job to make it as easy as possible for those of you being asked for input and for me to put it all together in a useful and visually acceptable format.

Celia Kirby, Institute of Hydrology

Midlands news

Representation on the Midlands Section Committee has been expanded, and now includes **John Adams**, **Richard Cross** and **Rachel Spence** (Environment Agency), **David Mitchell** (University of Wolverhampton), **Paul Webster** and **Chris Bradley** (Birmingham University) **Richard Douglas** (Severn Trent Water), **Ian Reid** (Loughborough University), **Peter Downs** (Nottingham University), **Rod Hawnt** (Informetric Ltd), **Rob Wilby** (University of Derby) and **Richard Boak** (Water Management Consultants).

In March 1999 there will be a one-day Midlands or National Meeting on the Easter Floods, probably at the University of Birmingham, and in June a site visit/social event, taking in the (Worcestershire) Stour Improvement Programme and Severn Valley Railway.

For details about the Midlands Section, contact Paul Webster *(tel 0121 414 5055, email p.webster@bham.ac.uk)*

Travel grants

Grants are available from the Exeter Fund, administered by BHS, for hydrologists to attend the 22nd General Assembly of the International Union of Geodesy and Geophysics (IUGG) to be held at the University of Birmingham between *19 & 30 July 1999* (see page 15). Applications should be made by *31 January 1999*.

BHS Travel Grants of up to £200 are also available to help members whose travel expenses are not met by an employer to attend scientific meetings. The committee has allocated a budget of £2000 for the coming year. The scheme is primarily intended to help younger members, who will be given priority, but it is open to all. Successful applicants will be expected to produce a short report for *Circulation*. Applications should be received by *31 March 1999* for the coming year's awards.

Anyone wishing to apply for money from the Exeter Fund or a BHS travel grant should contact the Hon. Treasurer, **Terry Evans** *(Tel. 01353 862723, email TEEVANS100@AOL.com)*

New members

We welcome the following members to the Society:

Sarah D Alloisio	Dept of Civil Engineering, University of Birmingham
Toff Anderson	The Meteorological Office
Kathryn Bloxham	SEPA
Rachel J Evans	Yorkshire Water Services
Daniel A Everitt	Environment Agency
Gail L Hamilton	Glasgow
Neil G C Hardie	Babtie Group
Sue Hornby	Dept of Civil Engineering, University of Birmingham
Jonathan P Hunter	Rustington, West Sussex
Peter Idialu	Chevron Nigeria Ltd
Anne Kemlo	W S Atkins Water
Adam H Nicholls	Environment Agency
David G Pettifer	Jeremy Benn Associates
Thomas W E Saville	Sir William Halcrow & Partners
Henry M Sichingabula	Dept of Geography, University of Zambia
Clare J Wheeler	Environment Agency
Alastair J Wilson	Environment Agency

New PhD thesis:
Rainfall boundary conditions for hydrological design

Congratulations to **Paul Webster** on the award of his PhD from the University of Birmingham. Paul's thesis is entitled "Rainfall boundary conditions for hydrological design". It explores the problems of estimating rainfall depths for given durations and return periods, the distribution of design rainfall over a catchment, and the design combinations required to give a flood of specified return period.

The results of two case studies are presented, for Hong Kong and Pakistan. The fitting of frequency distributions to samples of data extracted from a fully known parent distribution confirmed the large confidence intervals for quantiles. An alternative model for estimating quantiles with high return periods, conditioned by the physical maximum of precipitation, was proposed and illustrated. It was found that a distribution with concentric isohyets results in slightly lower values of areal rainfall, though slightly higher values of peak discharge compared with spatially uniform rainfall.

The relationship between the return period of a flood and that of the causative rainfall was investigated using a continuous rainfall-runoff model. For observed rainfall series from the UK, consistent results were obtained that contrast with recommended procedures in the *Flood Studies Report*. It was found that annual maximum floods of a given return period result from storms with a *lesser* return period, falling on wetter catchments, than assumed in the *FSR*.

The results of this work are considered important, given the likely continued role of event-based procedures for design flood analysis.

Leverhulme Trust award

The Society welcomes recognition of the worth of hydrology by other bodies. In this year's round of Leverhulme Trust research awards to institutions, there were three grants under the applied sciences heading.

One of these, for £104 660 over two years, was to **Prof. J.A. Dearing** and **Dr D.J. Siddle** (University of Liverpool) and **Prof. R. Thompson** (University of Edinburgh) for "Historical impacts of land use and climate on hydrology in a pre-alpine landscape".

Frank Law

Indian hydrology journal

The Society has been pleased to receive copies of the *Journal of Applied Hydrology* from the Association of Hydrologists of India. They span from Vol. IX No. 1 (1996) to Vol. XI No. 1 (1998), each with about 14 papers of about 7 pages each.

The Journal costs US$ 80 per annum, or US$ 15 to its overseas members (surface mail included). The contact address is The Editor, Journal of Applied Hydrology, c/o Department of Geophysics, Andra University, Visakhapatnam, 530003 India.

If any university department has a regular collaboration with Indian hydrologists and would like to have these volumes, will they please contact Frank M Law at the Institute of Hydrology. The IH library also holds archive copies for future reference.

Meetings

UPLANDS 1999 — PROBLEMS, PRESSURES AND SOLUTIONS
Durham, UK
18 - 21 April 1999

This conference features sessions on climate change and water resources, land degradation, wildlife conservation, managing multiple land uses and public policy.

There is a field day on Tuesday 20th April, with excursions to the North York Moors National Park and Upper Teesdale, followed by the Conference Dinner addressed Sir Fred Holliday of Northumbrian Water.

Speakers include Lord Selborne (President, Royal Geographical Society), Professor Ian Mercer (Association of National Park Authorities) and speakers from many universities, the Environment Agency, the Countryside Commission, MAFF, Scottish Natural Heritage, English Nature and other bodies.

Registration opens at 16.00 on Sunday 18 April at Hatfield College, University of Durham.

For further details please contact the organising committee: Professor Tim Burt, Environmental Research Centre, Durham University, Durham, DH1 3LE.

Call for papers for two symposia on WETLAND HYDROLOGY at the EGS General Assembly The Hague, The Netherlands 19 – 23 April 1999

Two symposia on wetland hydrology and water resources will be held as part of the 24th General Assembly of the European Geophysical Society.

The first is entitled ***Hydrology of wetlands*** and will focus on hydrological process studies (especially evaporation), water balance estimates and examples of hydrological functions (such as flood storage, groundwater recharge and nutrient cycling), from wetlands throughout the world.

The second, ***Wetlands, water resources and wise use***, will probe some important inter-relationships between wetlands and water, in tropical and temperate systems, in terms of, for example: wetland wise use and sustainable development strategies; multiple use considerations; the connectivity between ecosystems and biological diversity through wetlands and water; effects of engineering projects, such as dams; wetlands and water quality; wetlands and catchment management; women, wetlands and water, and other relevant topics.

Papers are invited. For details please contact **Dr Mike Acreman**, Institute of Hydrology, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB, UK (Tel 01491 692443 , Fax 01491 692424 , Email m.acreman@ioh.ac.uk).

For information on EGS and registration visit the web site: http://www.copernicus.org/EGS/EGS.html

Call for papers / posters
XXII IUGG GENERAL ASSEMBLY
Birmingham, UK
18 – 30 July 1999

Five IAHS Symposia and five IAHS Workshops will be held during this important international assembly.

The symposium themes are *Hydrological extremes; Interactions between the cryosphere, climate and greenhouse gases; Impact of land-use change on nutrient loads from diffuse sources; Integrated methods in catchmetn hydrology – tracer, remote sens-ing and new techniques; Impacts of urban growth on surface and ground water quality.*

The workshops are on *Global databases; Hydro-ecology; Hydrology of ice-covered rivers; Regionalisation of model parameters; Surface-groundwater interactions — quality and quantity.*

For further information see the IAHS circular at http://www.wlu.ca/~wwwiahs/bham99.htm, *or* the IUGG home page at http://www.bham.ac.uk/IUGG99/, *or* contact the IUGG99 Secretariat, School of Earth Sciences, University of Birmingham, B15 2TT *(tel 0121 414 6165, fax 0121 414 4142, email IUGG99@bham.ac.uk).*

CALL FOR PAPERS
International symposium on HYDROLOGICAL AND GEOCHEMICAL PROCESSES IN LARGE-SCALE RIVER BASINS
Manaus, Brazil
16 - 19 September, 1999

This conference, organised by the HiBAm programme (Hydrology and Geochemistry of the Amazon Basin) will concentrate on the Amazon and other large (defined as $>10^4$ km^2) tropical basins. It will address all aspects of their hydrology, geochemistry and ecology and their general role as pathways of material transport to the sea.

One-page abstracts should be submitted by **31 January 1999**, by email if possible, as an attached Word file. Registration fees will be US$ 200. For further details, please contact Manaus'99, CP 7091, Lago SUl, CEP 71619-970 Brasilia, DF, Brazil, fax +55 61 248 5378, email jean.guyot@apis.com.br

Diary

11th November 1998
Welsh Hydrological Group meeting
"Long-term implications of logging in tropical climates"
Venue: University of Wales, Swansea
Contact: Steve Taylor *(tel 01222 770088, fax 01222 362 094)*

17th November 1998
UK Groundwater Forum Seminar
"Low flows and wetlands: setting objectives for sustainability"
Venue:John Flett Lecture Theatre, Natural History Museum, London
Contact: David Macdonald, BGS, Wallingford, OX10 8BB *(Tel 01491 838800, Fax: 01491 692345, email gwforum@ua.nwl. ac.uk, web site http:// www.nwl.ac.uk/gwf)*

18th November 1998
BHS Midlands Section half-day meeting
"Forecasting rainfall and floods"
Venue: Environment Agency, Nottingham
Time: 14.00 (coffee from 13.30)
Contact: Richard Cross *(Tel 0121 711 2324, fax 0121 711 5824, email richard. cross@environment-agency.gov.uk)*

25th November 1998
Scottish Hydrological Group meeting
"A sideways look at the Balquhidder research catchments" — Dr R C Johnson (Mountain Environments; formerly at the Institute of Hydrology)
Venue: Lecture Theatre C, JCM Building, Kings Buildings, University of Edinburgh Time: 6.30 p.m. (tea 6 p.m.)
Contact: Andrew Folkard *(tel 0141 548 3280, fax 0141 553 2066, email a.m.folkard @strath.ac.uk)*

25th November 1998
BHS Southern Section meeting
"Hydrological data: quantity=quality?"
Venue: Imperial College, London
Contact: Dr Adrian Butler *(tel 0171 594 6122, email a.butler@ic.ac.uk)*

12th December 1998
Royal Met. Soc. (Scottish Branch)
"Forest evaporation worldwide" — Prof. Ian Calder (Consultant; formerly at the Institute of Hydrology)
Venue: Dept of Geography, Edinburgh University, Drummond Street
Time: 5.30 p.m. (tea 5 p.m.)

16th – 19th November 1998
Conference: "Water resources variability in Africa during the 20th Century"
Venue: Abidjan, Ivory Coast
Contact: ORSTOM, Antenne Hydrologique, 06 BP 1203 Cidex 1 Abidjan 06, Côte d'Ivoire *(Fax. +225 450076, email: 101727.2773 @compuserve.com)*

15th December 1998
Geological Soc. Hydrogeological Group
The 1998 Ineson Lecture: "Conquering hydrogeological uncertainty: structure and process imitating" — Prof. Steven Gorelick, Stanford University, USA
Venue: Burlington House, London[1]
Time: 2 p.m.
Contact: Brian Adams, Secretary of the Hydrogeological Group *(Tel. 01491 692411, Fax 01491 692424, e-mail badams@mail.nwl.ac.uk)*

17th – 19th December 1998
Institute of Environ. & Natural Sciences
"Upland management"
Venue: University of Lancaster
Contact: D. Hughes *(Tel & Fax 01229 463896, email DHughes314@aol.com)*

13th January 1999
BHS Southern Section meeting
"River Restoration: Is it worth it?"
Venue: Imperial College, London
Contact: Dr Adrian Butler *(see above)*

19th January 1999
SCI Agriculture & Environment Group
"Agriculture & catchment water quality"
Venue: London
Contact: SCI Conference Secretariat *(Tel 0171 235 3681, Fax 0171 235 7743, email: conferences@chemind.demon.co.uk)*

10th February 1999
Welsh Hydrological Group meeting
"Ten years after water privatisation — better or worse?"
Venue: Old Course Hotel, Chepstow
Time: 5.30 for 6 p.m.
Contact: Steve Taylor *(details above)*

17th February 1999
BHS Pennines Hydrological Group
"Hydrological impacts of climate change"
Venue: Dept of Geography, University of Huddersfield Time: 13.00
Contact: Dr Kevin Tilford, Dept of Civil & Environ. Engineering, University of Salford, Manchester M5 4WT *(Tel 0161 295 3458, Fax 0161 295 5060, E-mail k.a.tilford@civils.salford.ac.uk)*

22nd February 1999
BHS National Meeting + Geol. Soc.
"Modelling groundwater - surface water interactions — ecology, low flows and wetlands" — *(all day meeting)*
Venue: ICE, 1 Great George St, London
Contact: Mike Acreman *(Tel 01491 838800, Fax: 01491 692424, email m.acreman@mail.nwl.ac.uk)*

24th February 1999
BHS Midlands Section half-day meeting
"Groundwater modelling, featuring the West Midlands Model"
Venue: School of Civil Engineering, University of Birmingham
Time: 14.00 (coffee from 13.30)
Contact: Richard Boak *(Tel 01743 231793, email: watman_uk@compuserve.com)*

25th February 1999
Scottish Hydrological Group meeting
"Hydrological influences on aquatic habitats in Scotland: modelling approaches" — Dr Chris Soulsby (University of Aberdeen)
Venue: Lecture Theatre A1, Cottrell Building, University of Stirling
Time: 6.30 p.m. (tea 6 p.m.)
Contact: Andrew Folkard *(as above)*

17th March 1999
BHS Southern Section meeting
"Innovative techniques for flood investigation: the Galway experience"
Venue: Imperial College, London
Contact: Dr Adrian Butler *(see above)*

29th March 1999
Scottish Hydrol. Group + Geol. Soc.
"Celtic hydrogeology and the era of integrated catchment management"
Venue: University of Strathclyde
Contact: Andrew Folkard *(as above)*

9th April 1999
Welsh Hydrological Group field visit
"Hydrological aspects of the National Botanical Gardens, Cardiff"
Venue: The National Botanical Gardens
Contact: Steve Taylor *(details above)*

21st April 1999
Scottish Hydrol. Group + Geol. Soc.
"Water Framework Directive"
Contact: Andrew Folkard *(as above)*

19th – 30th July 1999
IUGG Assembly + BHS/IAHS meetings
Venue: Birmingham, UK
Contact: Dr Gordon Young *(Fax +1 519 8460968, email 44iahs@mach1.wlu.ca, web http://www.wlu.ca/~wwwiahs/index.html)*

Copy deadline for *Circulation* No. 60 4th January 1999