No. 76 February 2003

THE NEWSLETTER OF THE BRITISH HYDROLOGICAL SOCIETY

Circulation

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BHS second international conference

Imperial College, London, 12–16 July 2004

Abstracts (maximum 500 words) are invited – by *30th April* – of papers or posters to be presented at the Society's 2nd International Conference, to be held next summer at Imperial College. The title *"Hydrology: Science and Practice for the 21st Century"* has been developed into six themes. The first circular was issued with *Circulation 75.* The web site is at *www.hydrology.org.uk/bhs2004.*

BHS2004 is a great opportunity to share experiences with hydrologists from around the world. This is the last reminder to potential contributors to submit your abstract. The form can be downloaded from the web site or obtained from **Dr Adrian Butler** *(email bhs2004@imperial.ac.uk, fax 0207 594 6124).*

Environment Agency sponsorship

The Environment Agency is offering sponsorship to cover the registration fee to encourage young hydrologists (who are not their own employees) to attend this conference.

Authors of papers and posters on recent research and projects will be given preference, but others will not be excluded. The Agency is particularly keen to encourage students and those just starting their careers who live, work or study in England and Wales and would like to know more about a hydrological career in the Agency.

Details of the application procedure will appear in the Second Circular, due out in September 2003.

C+ returns with two flood articles

Four weeks of flooding in Eastern Scotland — how rare was it? *Alistair Cargill*

Not quite as bad as 1947! — the January 2003 Thames flood *Terry Marsh*

President's piece

The last quarter has been the quietest, for the Society, during my term as President. Floods, however, continue to make headline news with repetitious regularity. Parts of the Thames, I am told, have been at their highest since 1947. Interestingly, North West England has once again escaped extreme flooding. No doubt its turn will come. But it does illustrate the variability of hydrological impacts, even in a country as small as the United Kingdom, and the importance of geographically widespread monitoring and data collection.

Two very interesting meetings are planned in March and April. *"Hydrometry in a changing environment"* on 3rd March has two themes: measurements and their use. This meeting has been planned jointly with the Royal Meteorological Society. **Max Beran** will talk about making sense of hydrological record breaking, and will ensure that we put recent events in proper perspective. The meeting on 16th April (held jointly with the British Dam Society) will discuss probable maximum precipitation and dam safety.

John Rodda has written a short note about the UN International Year of Freshwater. BHS has not specially organised any meetings specifically on this theme, mainly because we had not been aware of this attribution to 2003 when planning the programme. However, CEH Wallingford is holding an event in September, in association with a number of other bodies, and your Society will be supporting this. **Celia Kirby** is on the organising committee and they are planning a high profile two-day event, designed to attract a technical audience on day one and the general public on day two.

Planning for the 2nd International Conference (to be held at Imperial College from 12th to 16th July 2004) is now moving into top gear. **Howard Wheater** is chairman of the main committee, **Bruce Webb** of the scientific programme committee and **Adrian Butler** of the local organising committee. The overall title *"Hydrology: Science and Practice for the 21st Century"* has been developed into six themes. Details of these, along with the names of the international convenors, appeared in the first circular (issued with the last *Circulation*). It also contained the call for abstracts, which may be sent in now, but must be received by ***30 April***. If you have lost the form, it can be downloaded from the web site ***www.hydrology.org.uk/bhs2004***. Any enquires should be made to Adrian Butler *(Fax 0207 594 6124 or email bhs2004@imperial.ac.uk)*. Please remember that the next national hydrological symposium will be in 2006 at Durham. BHS2004 is your opportunity to share experiences with hydrologists, not just in the UK, but also from abroad. You will not get another reminder, so why not set down your ideas now and send an abstract in early (maximum 500 words)?

Once again, I have to report some changes to the main and section committees' membership, thank those leaving for their past service and welcome those taking on new roles. **Samantha Green** has resigned from the national committee, as she is no longer working in hydrology. **Suzanne Wales** has agreed to take over as the young members' representative. Adrian Butler is also leaving the main committee after very many years as the representative and leader for the South East Section. Adrian will continue to serve the Society in the preparations for the 2004 conference but is handing over the reins of the section. **Kevin Tilford** has stepped down as Chairman of the Pennines group, because of work commitments. Kevin has also given very many years of service to both the Society and the regional group.

I am particularly please to welcome aboard in the regions **Bob Vaughan** (Environment Agency, Wales), who is leading the revival of a Welsh Section, and **David Collins** (Salford University) who takes over as chairman in the Pennines. They will each be setting up a committee to get their sections up and running again: please let them know if you would like to contribute.

John Griffin is looking at the redevelopment of the web site. This involves firming up a specification, which exists in draft, and overseeing a contractor to develop the site. If you have any ideas about how you would like to see the website develop, please let John have your thoughts *(contact details on the front page)*.

Peter D Walsh
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New committee members

As well as the new Hon. Secretary, **Andrew Black** (lecturer in physical geography, University of Dundee), and the BHS President-Elect, **Bruce Webb** (Professor of physical geography at the University of Exeter), we have three new committee members.

Joe Pearce is a hydrologist with the Environment Agency's Southern Region. He has attended committee meetings previously, deputising for Peter Midgley, and has taken the lead on defining hydrological competencies.

Dr Sue White is a senior lecturer in hydrology and hydraulics at the Institute of Water and Environment, Cranfield University, Silsoe, Beds. Sue has experience in developing and applying catchment and river process models, particularly for catchment planning, erosion, sediment and pollutant transport, sedimentation and ecohydrology. Her current research is in developing monitoring and modelling approaches for diffuse source pollutants, including sediment, to produce more robust methods for assessing management options. She is also studying impacts of environmental change (climate, land use and land management) on water resources and water quality.

Suzanne Wales is a hydrologist with Halcrow Group Ltd in Swindon. She has a background in physical geography and water resources technology and has worked mainly on UK-based consultancy projects for the Environment Agency, water companies and local authorities, specialising in flood estimation, hydraulic modelling, water resources planning and low flow hydrology.

Suzanne is currently producing Catchment Flood Management Plans for the Environment Agency. She aims to achieve chartership through CIWEM and to broaden her technical knowledge through overseas projects. She was recently co-opted onto the Main Committee as the Representative for Younger BHS Members, replacing **Sam Green**, who is no longer active in hydrology. Suzanne is also on the Education and Training subcommittee.

Past president on SEPA board

Sue Walker joins the SEPA Board

Congratulations to past BHS president **Professor Susan Walker** (Aberdeen University) who has been appointed as a non-executive Board member of the Scottish Environment Protection Agency (SEPA) from 1st January 2003. The appointment lasts for 3 years. This complements her other non-executive Board roles with Scottish Natural Heritage and the Deer Commission for Scotland and her membership of a ministerial Fisheries Committee.

International Year of FreshWater

WaterYear2003

The International Year of FreshWater 2003 was launched at the United Nations, New York, on 14th December 2002 by UN Secretary General **Kofi Annan**, following the agreement of the UN General Assembly. The resolution promoting the Year was initiated by the Government of Tajikistan and was supported by 148 nations.

The aim of the Year is to raise awareness of the importance of protecting and managing freshwater. It is in line with the Millennium Declaration that resolved to halve by 2015 the proportion of people who are unable to reach or afford safe drinking water. It follows from the recommendations made at the International Conference on Freshwater, Bonn, in December 2001, and those that came out of the World Summit on Sustainable Development in Johannesburg last year.

All the bodies and agencies of the United Nations with programmes in freshwater, i.e. the members of the former UN ACC Sub-committee on Water Resources, now known as UN Water, are taking part, together with a number of national organisations. UNESCO is taking a leading position and **Koichiro Matsuura**, its Director General, has appointed **Prince Talal** of Saudi Arabia as the Organization's Special Envoy for Water.

The Third World Water Forum, which will take place in Kyoto in March, will be an important event in the Year, and towards the end the IAHS Symposium will be held in Rome in early December: "The Basis of Civilisation — Water Science?" will include a session on some the achievements of the International Year.

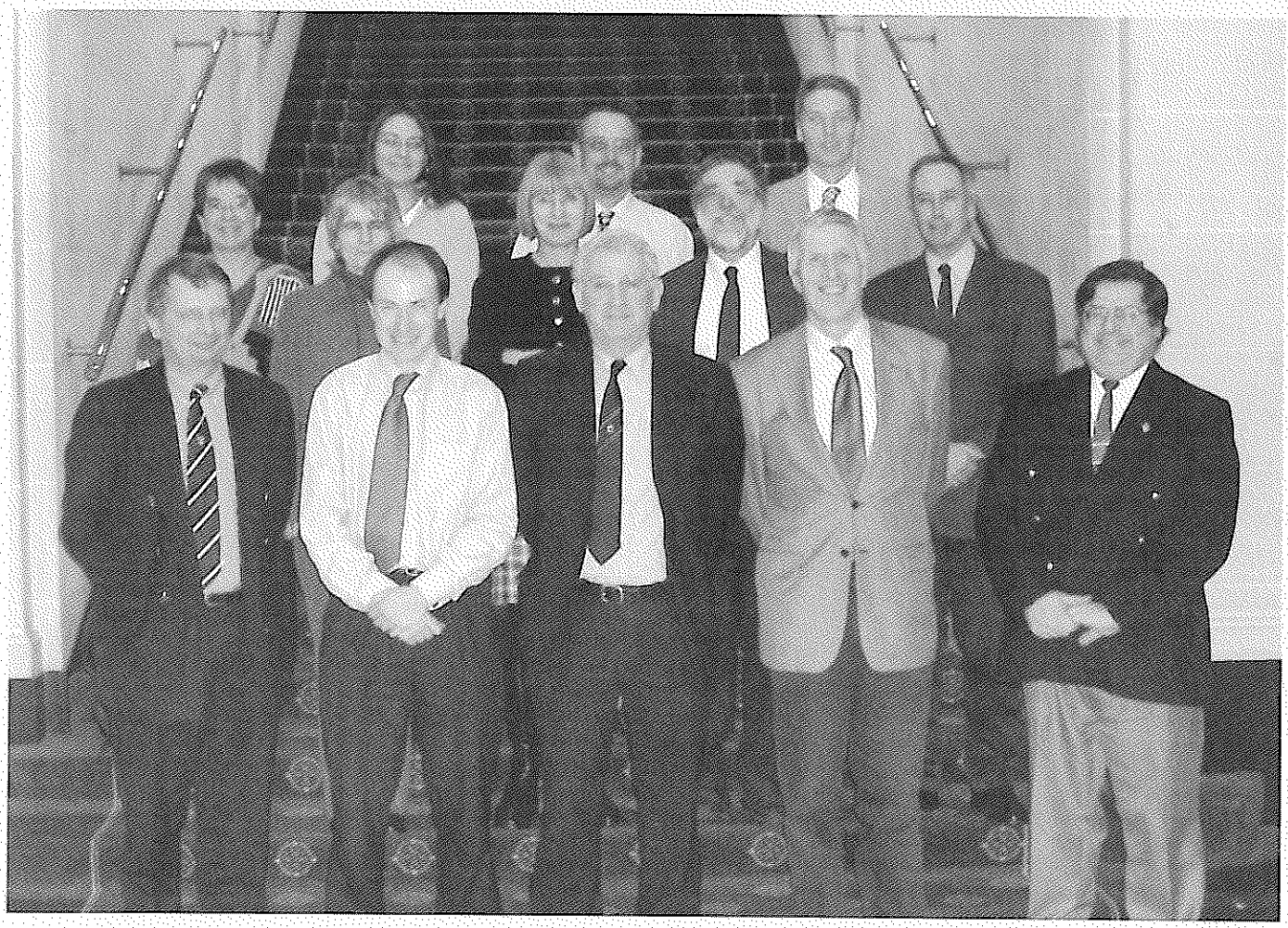
The relevant websites are *www.wateryear2003.org* and *www.cig.ensmp.fr/~iahs*

John C. Rodda

BHS is participating in the two-day event at CEH Wallingford on 9th and 10th September. Details will be publicised in Circulation.

The BHS committee at their January meeting

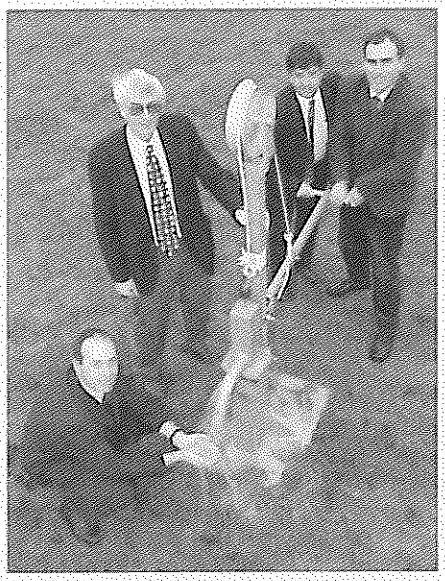
Front row (left to right): Steve Parsons, Andrew Black, Peter Walsh (President), Bruce Webb, Tim Fuller; *Middle row:* Sue White, Hilary Smithers, Celia Kirby, John Griffin, Ian Littlewood; *Back row:* Suzanne Wales, Joe Pearce, Murray Dale



International water resource centre launched at CEH

A new global resource centre providing access to world-leading water expertise for developing countries, NGOs and international agencies was launched at CEH Wallingford on *6th February* to help deliver the UN's development goals.

Sponsored by the UK government's Department for International Development (DFID), OASIS is led by three internationally renowned water research bodies (CEH Wallingford, the British Geological Survey and HR Wallingford) and is a network of over 20 specialist organisations.

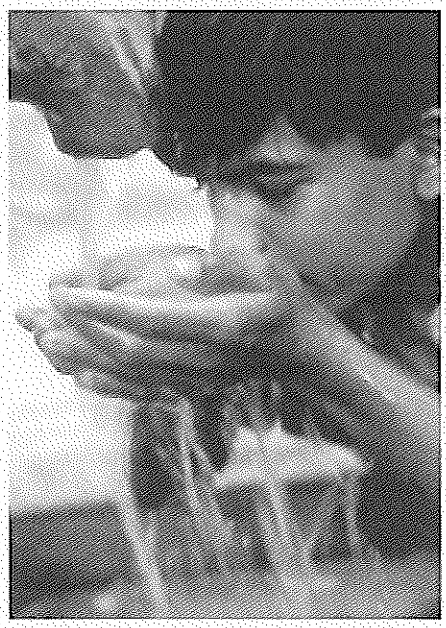


DFID Hydrological Adviser Dr Mike Acreman (CEH) washes his hands, watched by John Chilton (BGS), while Geoff Pearce (HR Wallingford) and Rob Flavin (CEH) man the pump.

Speaking at the launch, OASIS manager **Rob Flavin** said, "Our access to world-class expertise in all aspects of water resources management will help DFID and its partners deliver their contribution to the UN's Millennium Development Goals (MDG). Our main aim is to help achieve these goals, and we will use all the specialist skills and knowledge at our disposal to tackle the water crisis in the developing world. Through this work we can alleviate poverty and make a difference to people's lives. As a practical example of our commitment to make a difference 'on the ground', we are offering one day's free consultancy to appropriate governmental and non-governmental organisations based anywhere in the world.

UK-based NGO WaterAid (featured in the last *Circulation*) will be one of the first organisations to benefit from the services offered by OASIS.

Simon Trace, WaterAid's Head of International Operations, said "OASIS is looking at existing knowledge of groundwater quality in the countries where we work. This information will help us to prepare a water quality strategy for each country and enable WaterAid to improve access to safe drinking water. The OASIS contribution is proving invaluable and an important resource."



OASIS offers a range of services, from strategic thinking to cutting edge research, and from capacity building to operational advice and design. The aim is to grow the network to over 30 organisations within two years and include partner resource centres from developing countries.

Interested organisations can find more information on the OASIS website: *www.oasis-water.net* or from Rob Flavin *(tel 01491 692406, email rwf@ceh.ac.uk)*.

Second international symposium on flood defence

10-13 September 2002
Beijing, China

This symposium series provides a forum for reviewing state-of-the-art studies on flooding and its related engineering and non-engineering strategies. It focuses on a better understanding of flooding and environmental problems, different perspectives evolved, climate change and its impact on extreme hydrological events, and new approaches to studying flood control strategies.

The 1st symposium was two years ago in Germany and the 2nd one was in Beijing last September [1]. It attracted more than 200 researchers, practitioners, educators and public officials working or interested in flood control from about 35 countries and regions. There were eleven keynote speakers, ten invited papers given by distinguished international scientists and roughly three hundred contributed manuscripts. I was pleased to see many participants from China, who would normally be unable to attend this type of international conference if it were held abroad.

The symposium was divided into two parts: plenary sessions (day one) and parallel sessions (days two and three). It was useful to attend the plenary sessions where keynote speakers presented their latest research activities. Among the highlights were **Prof. Erich Plate** (ex-President of the International Association for Hydraulic Engineering Research), who gave a talk on a water management project in the Mekong river; **Prof. Roger A. Falconer** (Cardiff University) presented an integrated flood management scheme, and **Prof. Kuniyoshi Takeuchi** (President of the IAHS) who talked about flood defence practice in Japan and abroad.

It was a precious opportunity to meet so many leading experts in the field at the same venue (an important feature of attending international conferences). There were four parallel sessions in the following days, which were more tractable than some mega-conferences where dozens of sessions run simultaneously. I focused my time on the sessions linked with GIS, DSS (Decision Support Systems), hydrology, flood risk and uncertainty analysis. It was noticeable that there was a large delegation from Holland, some of whom I met two months earlier in Cardiff during the Hydroinformatics Conference jointly organised by Cardiff and Bristol Universities.

My paper entitled "Seasonal Trends of Rainfall and Flow in South-West England"[2] described trend analyses carried out on seasonal rainfall depth, mean flow and peak flow, and return period of peak flows over three distinctive catchments in South West England. I found that there are general trends of increased volume of rainfall and runoff in winter and decreased volume of those in summer, which are in agreement with the current climatic model's simulation. However, the peak flows (both annual and seasonal) across three catchments appear to move in opposite direction, indicating the change of rainfall patterns or anthropogenic activities in the region. I was pleased to receive a number of comments and discussions about the paper and will extend the work to investigate the reasons for the disparity between mean flow and peak flow.

During the symposium, I attended quite a few talks and it was so exciting to listen to the latest research results from researchers coming from various parts of the world. The most striking demonstrations in the conference were those latest system development using Web, GIS and integrated Modelling tools. They were still very much in research stage but I could see that they were moving in the right direction. I recognised a few old faces and added some new ones. There were lots of discussions during the tea/coffee breaks and also during conference lunches/dinners. I also noticed that the symposium receptions in China were actually huge dinners, and very different from the simple wine and peanuts receptions in the UK.

During this trip, some contacts with Chinese counterparts were established or re-connected. Before the symposium, **Prof. Ian Cluckie** and I visited the Ministry of Water Resources in China and were received by **Prof. Zhang**, director of Hydroinformation Systems. Prof. Cluckie delivered an excellent talk on climate, flood and remote sensing, which lasted for three hours, immediately after his landing in Beijing. We visited the National Flood Warning Centre there, where real-time data from some major rivers in China were received and displayed. Catchment sizes in China are on a far larger scale than in the UK, and it was interesting to see a national flood warning system over such a large area. Prof. Zhang and his team were very keen to collaborate with us in Bristol on further research in flood forecasting practice. We also visited the China Institute of Water Resources and Hydropower Research, and met some researchers from its different research sections.

To summarise, the trip to China was very fruitful and the pre-set objectives were all successfully achieved. The conference was of definite benefit to my future research and teaching activities. The support from the Royal Academy of Engineering and British Hydrological Society was very helpful, and without it my trip would have been impossible.

References

[1] *http://www.irtces.org/isshhu/2ISFD.html*

[2] *Seasonal Trends of Rainfall and Flow in South-West England*, D. Han, I.D. Cluckie, & W. Kang, Proc. 2nd Internat. Symp. on Flood Defence, Beijing, 10-14 Sept. 2002

Dr Dawei Han
Water and Environment Management Research Centre, University of Bristol

Fifth wetlands workshop

Atlantic City, New Jersey, USA 21-24 October 2002

The Wetlands Workshops are organised by the Wetlands Workgroup and the Environmental Protection Agency annually and aim to provide a forum for furthering the understanding of wetland science through a variety of presentations and discussion sessions.

A BHS travel grant enabled me to attend the 5th Wetlands Workshop in Atlantic City, to present a paper on my PhD studies at Aston University into wet woodland hydrology. There were 230 representatives of four different countries and twenty US states, including regulators, academics, consultants, non-governmental organisations and even high schools.

The conference was opened by **K. Hodgekiss** (Director, Environmental Services Division, US Environmental Protection Agency, Region III), who concluded that wetlands formed an integral part of the USA's water provision strategies and national economy (through fishing, bird watching and eco-tourism), but were still one of the most fragile ecosystems in the environment.

Day one included presentations on educational and voluntary programmes in wetland protection, plus numerous case-studies of wetland restoration projects throughout the USA. My research is on the hydrological aspects of wet woodland creation in the UK, so I was particularly interested in the papers on the creation of forested wetlands. **R.K. Mogensen** (Marsh Resources Inc.) presented details of the design, construction and regulatory challenges associated with creating two hydrologically different forested wetland sites in North Carolina, each created to mitigate a road development. A site at Pott Creek involved restoring the floodplain of a large stream to provide suitable hydrology to develop a forested wetland. However, the forested wetland at White Oak Creek was designed to capture stormwater run-off and intermittent stream flows to establish its hydrology. Re-profiling and excavation generated the required end-point hydrology, but at White Oak Creek the site was so wet that many trees that were planted did not survive. This paper highlighted the importance of understanding the potentially different hydrological requirements of different tree species during their establishment phase and consequentially their growth phase.

L.P. Tedesco (Purdue University at Indianapolis) gave another presentation on development of floodplain forests, describing the Lilly Arbor Project, an experiment in urban riparian restoration along the White River in downtown Indianapolis. The experimental site was created (a) for the long-term study of floodplain and riparian restoration strategies, (b) to evaluate current restoration procedures, and (c) to monitor the long-term growth and development of an urban riparian forest and its function. Initial studies focused on the

success of different reforestation strategies involving tree planting using (a) containerised stock, (b) bare root whips, and (c) bare root whips with weed control. Within the site, hydrological inputs to the riparian forest are from groundwater, due to flooding restrictions associated with its urban location. After the first year of growth, there were no statistical differences in tree survival rates for the different restoration strategies. However, after three years of growth, the area planted using containerised stock had a 74% tree survival rate, compared to only 54% and 58% survival rates for bare rooted stock with and without weed control respectively.

Day two centred on identifying and classifying wetland areas by analysing the soils and vegetation. US wetlands are classified using a range of criteria including suitable hydrology and hydrogeology, appropriate hydric soils, and indicative wetland vegetation. Guidelines for classifying wetlands are used throughout the USA, and many of the presentations gave evidence of soils and species that fell outside the guidelines, but were still indicative of wetland areas.

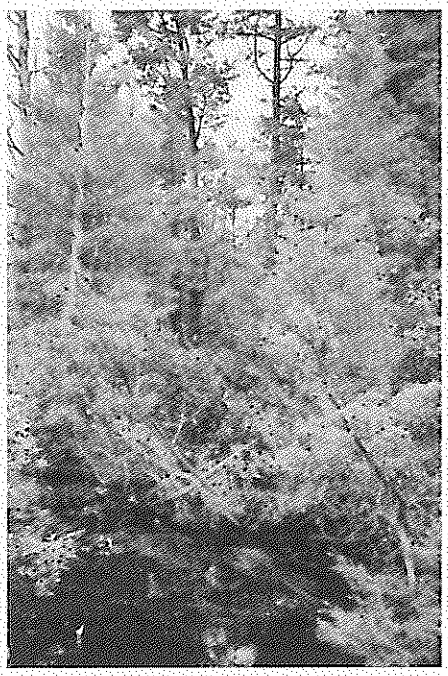
The use of geographical information systems (GIS) and remote sensing in wetland science was the topic on day three. Studies highlighted the use of GIS in analysing the distribution of, and changes within, wetland areas. The US National Resources Inventory used GIS to calculate that there had been an average annual net loss of wetlands within the USA of 13,040 ha per year between 1992 and 1997: 43% of this loss occurred in the nine south-eastern states, half of which was attributable to anthropogenic development (**S.J. Brady and J.J. Goebel**, Natural Resources Conservation Service).

The final day was spent on a field trip to the Pinelands National Reserve, an area of pine and cranberry swamp. Within the Pinelands, ephemeral pool areas (without water during the visit), form important areas for breeding tree frogs and salamanders. The afternoon was spent at the Edwin B. Forsythe National Wildlife Refuge, a 17,200 ha site where southern New Jersey coastal habitats are actively protected and managed for migratory birds. More than 80% of the refuge is tidal salt meadow and marsh with shallow coves and bays. To increase the habitat diversity, an 8-mile-long dyke was created to impound a 550 ha area, which now contains freshwater and brackish habitats.

My paper, presented on day two, described a method for determining evapotranspiration rates of wet woodland habitat in England based on the principles of lysimetry. The project aimed to provide hydrological design parameters associated with the development of water budgets for created wet woodland habitats. To provide information with respect to water use rates, wet woodland habitats were established within large lysimeters (2 m deep, 2 m radius) at two research sites, in Staffordshire and Warwickshire. Rainfall (R) data came from an automatic meteorological station and raingauges, and the change in the storage of water within the soil in the lysimeters (ΔS) was monitored using soil moisture probes. Evapotranspiration rates (ET) from the habitat were calculated using a water balance equation ($ET = R - \Delta S$).

Using standard reference crop values for 'normal' grassland provided by the Met Office (MORECS data), crop coefficients applicable to the wet woodland habitat were calculated. Designers of sustainable wetland systems can use these monthly values to determine the impacts of wet woodland habitat creation on local water resources. Initial results show that wet woodland habitats use between 10% and 50% more water annually than 'normal' grassland areas, but that the water use is related to the age of the trees within the habitat.

My paper was well received and the conference gave me the opportunity to discuss the differences in wetland protection between the USA and the UK. One of the most interesting features of US wetland protection is the use of 'mitigation banks'. The US government passed legislation a little over a decade ago declaring that there would be 'no net loss of wetlands' nationwide. To help to achieve this, wetland mitigation banks were developed: large areas (40 to 400 ha) of previously functioning wetlands were enhanced, restored or created. A given area of land is worth a certain number of credits (depending on its functionality as a wetland), which can be purchased by developers who cannot mitigate wetland loss on-site.



The Pinelands National Reserve



Edwin B Forsythe National Wildlife Refuge

I would like to thank the BHS and Aston University for part-funding my attendance at this conference. Not only did the trip allow me to present my research and increase my understanding of the current state of wetland science, but it also enabled me to experience the huge difference in scale between wetlands in the USA and the UK. The visit was beneficial in forging new international links, which I know will be useful both to me and to my colleagues at Aston who are involved in wetland research.

Katy Read
Aston University
(readke@aston.ac.uk)

C+ Circulation PLUS

Four weeks of flooding in Eastern Scotland — how rare was it?

C+ returns with two articles on recent floods: SEPA's Alistair Cargill reports on last autumn's flooding in eastern Scotland, while Terry Marsh, of the National River Flow Archive at CEH Wallingford, presents an initial analysis of the New Year floods on the Thames. Note that C+ covers six pages this time. Please submit ideas for future issues to the editor.

Introduction

Following a notably wet summer (e.g. June to August rainfall was approx. 200% above Long Term Average in eastern Perthshire and Angus) and a very dry September in the eastern half of Scotland, extreme flooding characterised the four-week period between October 22nd and November 22nd, 2002. Several major rivers that outfall on the east coast of Scotland experienced severe flooding, with 15 gauging stations (some on the same river) recording new peak flows.

The cause of these floods was mainly prolonged frontal rainfall, which, Werritty & Acreman (1985) say is the 'major cause of flooding' in Scotland. This rain was associated with deep lows centred over England and the southern North Sea, producing airflows from the south and south-east. Rain also swept in from the east and north-east as these depressions tracked further north up the UK east coast, but one notable flood event in Angus was generated by snowmelt. Homes and businesses from Aberdeenshire to the Borders were damaged, with the worst affected area once again being Morayshire, in particular the town of Elgin.

Description of events

Scottish Borders (Oct 21st - 22nd)

The first notable event was on the Tweed catchment in the Borders, and in particular the lower (easterly) half of the catchment. The highest flows were recorded on tributaries in the north-eastern portion of the Tweed basin — the Eye Water, Whiteadder Water and Blackadder Water — which all attained new peak flows. The main river Tweed itself was very high in its lower reaches as recorded at Sprouston and Norham gauging stations, both badly damaged during the event. Despite this spatial concentration of high flows towards the eastern half of the catchment, a north-western tributary, the Manor Water, recorded its highest stage but second highest flow (due to rating changes) since recording began at the Cademuir station in 1968. Most other western Tweed watercourses were not nearly as high as they were during the well-known event in October 1977.

The origins of the flooding reside with heavy and prolonged frontal rainfall from Oct 20th to 22nd. At Abbey St Bathans (Whiteadder basin) 112 mm was recorded in 72 hours: 76.4 mm fell on the 21st alone. The Met Office in Glasgow had an unconfirmed report of over 85 mm in 24 hours at a location in Berwickshire. Over the 72 hours from Oct 20th to 22nd, frontal rain persisted over the catchment, firstly from a southerly direction, then south-easterly and easterly as the depression moved east across England. This allowed more moisture to be driven in off the North Sea to produce heavier rainfall (clearly reflected in the rainfall profiles recorded by SEPA), inevitably impacting upon the eastern parts of the catchment. The relatively small Eye Water catchment (119 km^2), closest to the east coast, arguably displayed the most significant response to this rainfall. The main towns in the Borders affected by inundation were Eyemouth, Kelso, Coldstream and Innerleithen.

Aberdeenshire (Oct 22nd – 23rd)

The same frontal rain system also impacted on Aberdeenshire as the depression moved north up the east coast. Rain had already fallen over parts of Aberdeenshire in the preceding days, producing antecedent wetness in many catchments. Like the Tweed basin, the heaviest frontal rainfall was of an easterly origin. The River Don (one of two main rivers which outfall into the North Sea at Aberdeen) was at its highest level in 30 years of record. Indeed, all three of its primary reporting gauging stations recorded new peaks: Bridge of Alford and Haughton on 22nd and Parkhill on 23rd October. Flood inundation affected the towns of Kintore and Inverurie. The River Ugie in Buchan (further to the north-east) also recorded a new peak within a record dating from 1972. The easterly 'coastal' location and orientation/aspect of the Ugie basin is not unlike that of the Eye Water in the Borders. Extreme flooding on this river is again testament to the directional nature of this frontal system.

Angus (Nov 2nd - 3rd)

A new peak was attained on the North Esk in north-east Angus on the morning of Nov 3rd . The level recorded at SEPA's Logie Mill gauging station was 4.2 m stage. The previous highest was 3.4 m, recorded in 1984, but the instrumental record is not particularly long, originating only in 1983. A tributary of the North Esk (the West Water) also attained a new peak at SEPA's Dalhousie Bridge station. Although the presence of a depression played a vital role, the dominant flood-producing mechanism here was not frontal rainfall but snowmelt. Snow had accumulated for over a week on the southern flanks of the Grampians, quite a considerable accumulation for the time of year. A southerly air stream began to push into the region around 11 p.m. on Oct 31st and both wind-speed and air temperature continued to rise throughout Nov 1st. Winds intensified on 2nd, with temperatures averaging around +8 to 9° C, and rainfall soon followed, with approximately 20 mm falling between midday and midnight. High winds, temperature rise and rainfall combined to cause a rapid dissolution of the upland snowpack, producing a peak stage at 6 am on Nov 3rd. Figure 1 suggests that conditions were favourable for a large snowmelt event, as a partial de-stabilisation of the

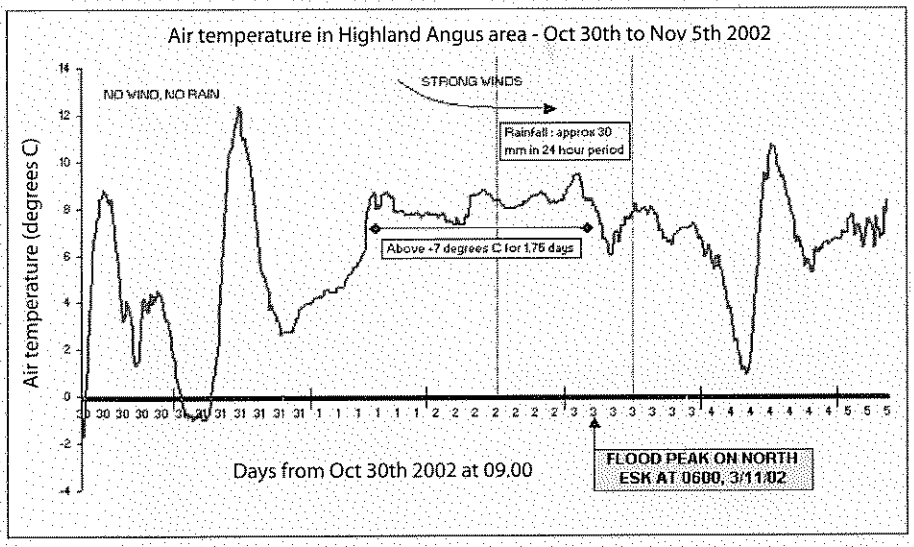


Figure 1 *Variations in air temperature between Oct 30th and Nov 5th, as recorded at SEPA's Gella Bridge monitoring station. Annotation shows overlapping periods of high winds and rainfall that led to the flood peak on Nov 3rd at 0600 hours.*

snowpack had possibly already occurred as a result of large diurnal variations in air temperature on both 30th and 31st October. Some homes near SEPA's gauging station (including Logie Mill itself) suffered damage from high velocity flood flows, which inundated the properties after an embankment failed 50 yards upstream.

Morayshire (Nov 15th – 16th)
Rainfall was driven onto the Morayshire coastal fringe on Nov 15th and inland towards higher ground, due to the presence of a deep low centred in the northern North Sea. Rainfall persisted over two days, increasing in intensity as it met higher elevations and warmer air from the south-west. The upper reaches of the Lossie catchment and the Mosset Burn catchment experienced the highest rainfall totals, with 167 mm recorded at Torwinny in 52 hours. This is similar to the 150 mm that fell in 48 hours between June 30th and July 1st 1997 at nearby Relugas (Brown & Black, 1997). SEPA hydrologists predicted severe flooding on 15th, with the river peaking the following day. This new peak flow (within a record dating from 1959) caused severe damage in Elgin, as did the previous highest recorded peak in 1997. Flood inundation was also a hazard in Forres (Mosset Burn) and Rothes (Rothes Burn). The River Deveron (further west than the Lossie) also recorded a new peak flow in a record from 1960. Flooding occurred in Turriff as a function of the Gasey Burn backing up because of the high River Deveron, which itself directly impacted on the area around Huntly Castle.

Angus (Nov 20th – 22nd)
On 20th November, a frontal system of easterly origin produced 40-50 mm of rainfall over parts of the South Esk and North Esk catchments in Angus, as well as the more westerly River Isla catchment, a major tributary of the Tay. Rivers responded, reaching Flood Warning level on both the Isla and the South Esk. Catchments, already wet from this notable precipitation, responded even more rapidly on the following evening (21st), where rainfall from a south-easterly direction (of low intensity: 0.5-1.0 mm per hour) was orographically enhanced as it crossed the Highland Boundary Fault and climbed over the southern Grampians. Intensities increased towards 6-8 mm per hour, with 63 mm recorded at Rottal Lodge raingauge between 0900 on 21st and 0900 on 22nd. Severe Flood Warnings were issued for the Rivers Isla, Ericht and South Esk. Rivers peaked early on 22nd, with the South Esk attaining a new maximum flow at both Gella Bridge and Brechin gauging stations, while the North Esk recorded its second highest peak on record only 19 days after recording its highest (as described above). At least twenty homes were evacuated in Brechin, with several businesses also flooded.

Aberdeenshire (Nov 20th – 22nd)
The orographically enhanced rainfall of south-easterly origin that affected Angus on 21st continued north over the Grampians, crossing watersheds into the Dee and Don catchments of Aberdeenshire. Catchments already wet (possibly close to field capacity) from the previous day's rain, not to mention numerous rainfall episodes over the previous four weeks, also responded rapidly. The result was even higher peak flows than that of Oct 22nd at all three primary reporting stations (as above) on the River Don. Further damage was sustained to settlements along the Don valley, affected four weeks previously. A new peak flow was also recorded on the most downstream SEPA gauging station on the River Dee, at Park, which began systematic recording in 1972. Flooding from the Dee affected areas close to the town of Maryculter (see Figure 2).

Peak flow analysis/rarity estimates

The rarity for these new peak flows was estimated using the FEH statistical approach (IH, 2000). However, only single-site analysis was carried out for a number of reasons, including time constraints and consideration of some of the uncertainty issues surrounding pooling-group analysis, i.e. heterogeneity and the 5-T rule; data issues (not all AM records in FEH are correct/up to date) and notable differences found between FEH single-site and pooling-group design flows, as described by Cargill & Price (2001). The most up to

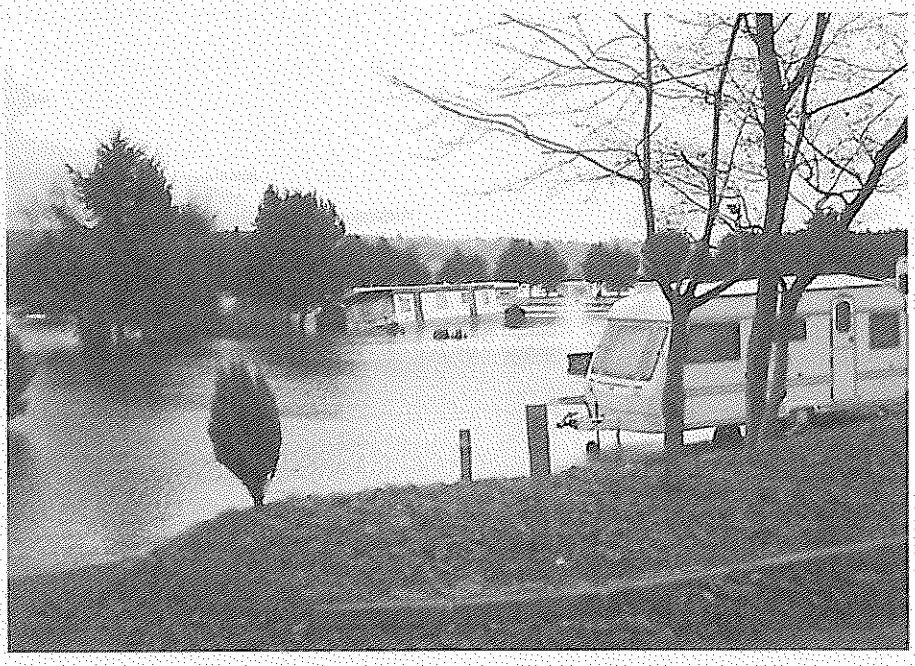


Figure 2 *Flooding of Maryculter Caravan Park, Deeside (photo Kenny Ross, SEPA)*

date AM (Annual Maximum) records from SEPA archives were used for the sites analysed (see Table 1).

Discussion

Table 1 shows that many of the recent peaks are extremely rare, by statistical estimation. This is not that surprising, given that sampling errors will be high as a function of executing only single-site analysis, in some cases on quite short records, e.g. the North Esk. Recent work (Cargill & Price, 2001) has shown that analysis by the FEH pooling-group approach may produce even rarer estimates for such events, which is not always corroborated by available historical data.

The recent events in Eastern Scotland are not unprecedented within the flood history of these catchments. Roy & Fox (1995) describe the importance of south-easterly and easterly airflows (associated with deep depressions over England) in producing prolonged and heavy rainfall, often leading to flooding in the Tweed basin. Past flood events that fall into this synoptic classification include those in 1891, 1911, 1948 and 1984 — they all produced high flows on the Whiteadder Water, as in this event. The recent Eye Water flood appears very rare by statistical methods. However, the instrumental record does not include the aforementioned, infamous 1948 flood, which destroyed railway and road bridges (Learmonth, 1950). If it did, the perceived rarity would certainly not be so great.

The November flooding in Morayshire is similarly not entirely unprecedented. Extreme flooding occurred in 1829 (Lauder 1830), 1915 (British Rainfall 1915), 1956 (Green 1958), 1970 (Green 1971) and 1997 (Brown & Black 1997), not to mention lesser events in 1995 and 2000. The most notable events were all associated with similar synoptic conditions and seasonality, i.e. a north-easterly airflow in the summer half-year. The rainfall patterns/isohyetal graphs of 1915, 1956, 1970 and 1997 show quite remarkable similarity. This 2002 event corresponds with a seemingly familiar synoptic signal, if not with the seasonality.

Instrumental records show that historically the largest events on the North and South Esk have occurred in the Autumn. The occurrence of high flows recently is thus nothing new. The previous highest peak on the North Esk (1984) was also associated with snowmelt, but occurred in the Spring. Hence evidence existed to suggest that any new peak flood would have a high probability of either occurring in the Autumn, and/or being generated by snowmelt. Black (1992) and Cargill (2000) have shown that a recognition of specific controls on flood behaviour (identified via POT flood series) can be used to reassess flood risk by 'component' statistical methods, providing arguably more useful results. However, the occurrence of rank 1 and 2 floods on the Don and North Esk within such temporal proximity clearly creates a problem when trying to assess flood risk by statistical means, even when using POT data. How can we experience two 'independent' floods of such perceived rarity within the space of a month?

Table 1 *Estimates of rarity for recent peak flows in Eastern Scotland, as recorded at SEPA gauging stations. The flow (cumecs), date and rank are also given. Rarity is expressed as a return period estimate in years. Return periods were assessed by single-site FEH analysis using the recommended GL distribution fitted by L-MOM. In each section 'Est. rarity' is the estimated return period in years of the new peak flows under FEH single-site analysis using the relevant AM station record up to 2001. In (e), 'Rarity inc. Oct peak', is the estimated return period of the November flood flows (at stations 11001, 11002 and 11003) where the earlier October 2002 peak flows are included as the Qmax for 2002.*

(a) ANGUS – November events

Hyd No.	River	SEPA station	Record start	Flow cumec	Date	Rank	Est. rarity
13007	North Esk	Logie Mill	1983	635	3/11/02	1	397
13009	West Water	Dalhousie	1985	222	3/11/02	1	56
13012	South Esk	Gella Bridge	1991	108	22/11/02	1	27
13008	South Esk	Brechin	1983	235	22/11/02	1	45

(b) BORDERS – October event

Hyd No.	River	SEPA station	Record start	Flow cumec	Date	Rank	Est. rarity
21009	Tweed	Norham	1960	1503	22/10/02	2	42
21016	Eye Water	Eyemouth	1968	115	22/10/02	1	275
21019	Manor Water	Cademuir	1968	39	22/10/02	2	57
21022	Whiteadder	Hutton Castle	1970	346	22/10/02	1	48
21027	Blackadder	Mouthbridge	1974	134	22/10/02	1	106

(c) MORAYSHIRE – November event

Hyd No.	River	SEPA station	Record start	Flow cumec	Date	Rank	Est. rarity
7003	Lossie	Sheriffmills	1959	126	16/11/02	1	136
9001	Deveron	Avochie	1960	224	15/11/02	1	60

(d) ABERDEENSHIRE – October events

Hyd No.	River	SEPA station	Record start	Flow cumec	Date	Rank	Est. rarity
10002	Ugie	Inverugie	1972	148	22/10/02	1	106
11001	Don	Parkhill	1971	436	23/10/02	1	70
11002	Don	Haughton	1970	266	22/10/02	1	45
11003	Don	Br. of Alford	1974	201	22/10/02	1	51

(e) ABERDEENSHIRE – November event

Hyd No.	River	SEPA station	Record start	Flow cumec	Date	Rank	Est. rarity	Rarity inc Oct peak
11001	Don	Parkhill	1971	454	22/11/02	1	81	51
11002	Don	Haughton	1970	269	22/11/02	1	48	35
11003	Don	Br. of Alford	1974	207	22/11/02	1	60	38
12002	Dee	Park	1972	858	22/11/02	1	51	*

The following is in part a belated answer to a question by David MacDonald of Binnie, Black and Veatch on POT usefulness for the Autumn 2000 floods, asked at the ICE/BHS FEH meeting in March 2002:

One approach to finding a solution would certainly be to consider the first River Don flood on Oct 22nd not to be independent and view it as a component of a series of inter-connected hydrometeorological events over time, which ultimately led to the generation of the Nov 22nd peak. Such a view has been expressed by Klemes (1993), who considered extreme floods to be the result of a combination of physical factors. Multiple frontal rainfall events, creating very wet catchments over the period of a month have influenced the production of a new peak flow on Nov 22nd on some Aberdeenshire rivers. The fact that a very high (new peak) flow was attained early within this process (Oct 22nd) should not necessarily decouple that event from the wider scenario of 'combinational' events. This school of thought could also be applied to the Autumn 2000 flooding in England and Wales, and indeed to the very recent New Year floods in central and southern England. In both cases, a sequence of multiple-rainfall events combined to saturate catchments and raise river levels (and groundwater levels in some catchments) in preparation for an extreme flood should another rainstorm come along, which it did. Ettrick *et al.* (1987) describe this

concept well: " The magnitude of a flood flow is related primarily to the storm rainfall and secondly to the catchment wetness prior to the start of the storm". If, as in some cases, flood peaks cannot be truly independent, POT series at least allow analysts to identify periods of 'ripening before the bloom'. The two November peaks on the North Esk are more difficult to explain by such an approach however, because of the differences in flood producing mechanisms, i.e. one with a snowmelt component and one solely from frontal rainfall.

New peaks on relatively short records, such as those in Angus, may not be all that significant, again due to sampling. However, the fact that two new successive peaks were recorded on longer instrumental records in Aberdeenshire, may provide better guidance (in a purely qualitative way) as to how extreme the hydrometeorological conditions over this four-week period possibly were. Wilby *et al. (1997)* state that, "Many of the observed changes in rainfall and runoff patterns of the last 20 years are consistent with an increased influence of the surface westerlies over maritime Europe, manifested by more northerly paths for the preferred tracks of Atlantic frontal systems". It is pertinent to say that the recent period was characterised by successive Atlantic systems tracking further south across the UK, thus leading to higher rainfall totals in the south and east, rather than the north and west, as is commonly expected in Autumn and Winter. The notion of increased hydroclimatic variability in Scotland (Foster *et al.*, 1997) may be a very appropriate way to rationalise recent events. However, it has to be borne in mind, especially when assessing flood risk, that characteristics of these floods have been before and will come again. Are the recent floods in Scotland really that rare?

References

Black, A.R. (1992) Seasonality of flooding in Scottish Rivers. Unpublished PhD thesis, University of St. Andrews.

British Rainfall (1915) The Moray Floods of 1915. British Rainfall p. 74.

Brown, R. and Black, A.R. (1997) Moray Floods, 1st-3rd July 1997. *Circulation* No. 55, August 1997. British Hydrological Society, Wallingford.

Cargill, A. (2000) Risk reassessment for extreme riverine floods in the UK: A heterogeneity approach. Unpublished PhD thesis, University of Dundee.

Cargill, A. and Price, D.J. (2001) Comparison of FEH and FSR estimates of design flood magnitudes in Scotland. MAFF 36th Annual Conference of River and Coastal Engineers, Keele University, June 2001.

Ettrick, T.M., Mawdsley, J.A. and Metcalfe, A.V. (1987) The influence of antecedent catchment conditions on seasonal flood risk. *Wat. Resour. Res.* 23(3): 481-488.

Foster, M., Werritty, A. and Smith, K. (1997) The nature, causes and impacts of recent hydroclimatic variability in Scotland and Northern Ireland. *Proc. Sixth National Hydrology Symposium*, University of Salford, September 1997, British Hydrological Society, 8.9-8.17.

Green, F.H.W. (1958) The Moray floods of July and August, 1956. *Scottish Geographical Magazine*, 14: 48-50.

Green, F.H.W. (1971) History repeats itself - flooding in Moray in August 1970. *Scottish Geographical Magazine*, 87: 150-152.

Institute of Hydrology (1999) *Flood Estimation Handbook* (5 volumes). Institute of Hydrology, Wallingford, Oxfordshire.

Lauder, T.D. Sir (1830) An *account of the Great Flood of 1829 in the province of Moray and the adjoining districts*. Adam Black, Edinburgh, 1830.

Learmonth, A.T.A. (1950) The floods of 12th August 1948 in south-east Scotland. *Scott. Geograph. Mag.* 66(3): 147-153.

Werritty, A. and Acreman, M.C. (1985) The flood hazard in Scotland, in Harrison, S.J. (ed.), *Climatic hazards in Scotland*. Geobooks, Norwich, 25-40.

Wilby, R.L., O'Hare, G. and Barnsley, N. (1997) The North Atlantic Oscillation and British Isles climate variability, 1865-1996. *Weather*, 52: 266-276.

Roy, M.G. and Fox, I. (1995) Flooding in the Tweed catchment – weather and orographic controls. BHS 5th National Hydrology Symposium, Edinburgh 1995.

Klemes, V. (1993) Probability of extreme hydrological events - a different approach. In: Kundzewicz, Z.W., Rosbjerg, D., Simonovic, S.P. and Takeuchi, K. (Eds), *Extreme Hydrological Events: Precipitation, Floods and Droughts*. Proc. Internat. Symp., Japan 1993. IAHS Publ. No. 213: 167-176.

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Not quite as bad as 1947! – the January 2003 Thames flood

For the second time in three years, a persistent series of vigorous Atlantic frontal systems — favouring a southerly route across the UK — produced exceptional autumn and early winter rainfall totals across much of southern Britain. These triggered sustained and brisk increases in river flows, culminating in extensive floodplain inundations towards year-end, continuing into January 2003. In relation to England and Wales as a whole, the relatively even distribution of the rainfall (both spatially and temporally) resulted in much less damaging impacts than the floods of late 2000. However, flows in many reaches of the Thames were the highest since the snowmelt-generated flood of March 1947.

Rainfall

Following a dry spell in August and September 2002, weather conditions changed and low pressure dominated synoptic patterns across southern Britain until year-end. Over a 12-week period from mid-October, rainfall at the CEH Wallingford Met station totalled a remarkable 320 mm – equivalent to 55% of the 1961-90 annual average. Rainfall totals were also exceptional for the Thames catchment as a whole – provisional data indicate that the October to December total for 2002 was >180% of the 1961-90 average; the second highest three-month accumulation (after 2000) for any three-month sequence since 1929. The immediate cause of the early January flooding was rainfall totalling 40-80 mm across much of the Thames catchment over the five days from December 27th; however the maximum intensities and individual storm totals were unremarkable – the event was primarily a response to sustained rainfall across a saturated catchment.

River flows

During the late summer and early autumn of 2002 flows in the Thames were considerably below average. However, soil moisture deficits were rapidly eliminated in the late autumn and, by early November, the flood risk was high across much of the catchment; minor overspills onto the floodplain were common. After a respite in early December repeated pulses of substantial rainfall produced high spates around year-end when levels in the Rivers Pang and Thame exceeded recorded maxima. With most other tributaries flowing close to bankfull, catchments fully saturated and baseflow contributions increasing rapidly, significant further rainfall on the 31st Dec / 1st Jan made extensive

inundation of the Thames floodplain inevitable.

Flows in the middle reaches of the Thames peaked in early January 2003. At Days Weir (Dorchester) where flows have been measured since 1938, the estimated peak flow has been exceeded only during the March 1947 flood. The nearby Sutton Courtenay gauging station – commissioned in 1974 – registered a new maximum flow rate and inflows from the River Thame were exceptional. Confirmation of the very notable magnitude of the 2003 event is provided by lock levels throughout the navigable Thames. At Reading and Oxford the January 2003 maxima rank third and fourth highest in series beginning in 1882. Rankings are generally less exceptional in the upper and lower reaches of the Thames, particularly over the stretch where flows were diverted into the Jubilee River (see below).

At Teddington (the tidal limit), the provisional highest daily flow ranks 12th in the 120-year flow record (Table 1); but still the highest since November 1974. For the Dorchester-Wallingford reach, a longer historical perspective is provided by the flood mark series for Shillingford Wharf (Table 2). This indicates that the 2003 peak was over 0.5 metres below the maxima of 1809 and 1821 (not necessarily implying a major difference in peak flows; conveyance on the Thames was different in the nineteenth century). The floods of 1774 and 1882 (unrecorded at Shillingford) are likely to also to have exceeded the 2003 level. Thus a ranking of around tenth would seem appropriate, over a 230-year timespan. This is supported by initial (single-site) FEH analyses which suggest a return period in the 25-35 year range for the Days Weir/Sutton Courtenay maximum flow. Return periods below the confluence with the Thame (at Dorchester) may have been higher but at Kingston the maximum daily naturalised flow had an estimated return period of only around 10 years – nonetheless flows remained above 400 cumecs for the longest period since the March 1947 event.

The January flooding caused exceptional and protracted transport disruption and massive floodplain inundation, but overall the impact was limited, given the very notable magnitude of the flood. At Maidenhead, the use of the Jubilee River avoided a repeat of the substantial flooding experienced in February 1990, when flows were significantly lower than this January. Nonetheless, around 500 properties were flooded in the Thames Valley including over 100 at Chertsey (where exceptional flow in the Chertsey Bourne was a major factor). Some 'clear-water' flooding was also reported (e.g. in the Chilterns) as water-tables reached the surface following groundwater recharge that exceeded twice the early winter average over wide areas.

Table 1 *Highest flow events (based on daily naturalised flows) at Teddington/ Kingston (1883-2003)*

Year	Floodmark *(m aOD)*
1809	47.25
1894	46.96
1821	46.83
1768	46.78
1947	46.71
1852	46.53
1929	46.4
2003	46.3E
1875	46.25

The 1947 Flood

Peak levels in the middle reaches of the Thames during the 2003 flood approached to within 0.2 metres of the March 1947 peak, and for some of those directly affected it was a distressing experience. However, the scale of the misery does not bear comparison with 1947 when, in the overture to the flood, post-war privations were compounded by one of the worst late-winters on record: February was the coldest in the 343-year Central England Temperature series. A sequence of severe blizzards affected transport and industrial production: the inability to move coal from the ports was especially disruptive, contributing to an extension in electricity rota-cuts (the many power lines brought down by the snowstorms also contributed). Severe agricultural losses were reported: four million sheep perished and the frosts destroyed much of the late potato crop. Snow accumulations and communication failures meant that many villages were cut off for lengthy periods.

The mid-March flooding itself greatly exacerbated the transport difficulties (the main LNER route from London was suspended for a week) and inundation of water treatment and sewage works produced water supply problems across the country (e.g. 1 million people were without water in east London) and a serious threat to public health. The flooding caused the shutdown of many hundreds of factories (some already on short-time due to the power cuts) including 58 in the lower Lee Valley.

With relatively few flood defences, poorly maintained drainage systems (many blocked by ice during the initial flooding), floodplain inundations were extensive and protracted (three to four weeks in much of the English Lowlands). In the Thames basin alone, the total of flooded properties (including approximately 3000 in Oxford, 1600 in Caversham and 1350 in Windsor, where the river was reportedly a mile wide) roughly equalled the national figure for the autumn 2000 floods.

Whilst the flood waters were still very extensive, the 'Great Gale' of March 16th caused considerable structural damage, brought down thousands of trees and telephone lines, severely hampering the rescue work of the emergency services. Access to farmland was impossible over much of the country and, with spring sowing postponed in many areas, a Commonwealth Disaster Fund was launched to help alleviate the misery: the food supply outlook was particularly bleak. Field Stations were established to help feed the stricken communities (one at Selby in Yorkshire catered for 20,000 people). The flooding touched the lives of everyone and those with direct experience would probably smile rather ruefully about any comparisons with the recent flood 'disasters' of 2000 and 2003.

Table 2 *Relative levels of historic floods at Shillingford Wharf (adapted from Griffiths, P.P. 1983. A Chronology of Thames Floods. Thames Water)*

Rank	Date	Naturalised flow *(cumecs)*
1	18/11/1894	806*
2	20/03/1947	714
3	17/09/1968	600
4	05/01/1915	585
5	23/11/1974	559
6	13/12/1929	552
7	21/02/1900	533
8	07/01/1928	526
9	04/01/1925	522
10	15/02/1904	517
11	16/02/1883	511
12	**02/01/2003**	**482**
13	28/02/1933	479
14	02/01/1936	478
15	**07/11/2000**	**463**

* Revised value (previously 1059 cumecs)

Comment

The January 2003 flooding provided another timely reminder that the floodplain forms part of the natural province of the Thames and its drainage function should not be compromised by inappropriate development. Inevitably, some will see the close juxtaposition of two exceptionally wet winters – with widespread flooding – as a signal of climate change. Some consistency with favoured climate change scenarios may be recognised (particularly the run of mild, wet winters) but model uncertainties and natural climate variability suggest that the association with flood risk can be made only very tenuously. Those looking for a positive spin would point to the decreased likelihood of extreme snowmelt/frozen ground floods (like those of 1947 and 1809) in a warmer world.

The Teddington/Kingston river flow series has its hydrometric limitations (particularly prior to 1951) but the addition of the recent maxima only serve to reinforce the long term lack of trend which characterise the annual maxima series (Figure 1). A tendency to an increase in the frequency of high flows for the Thames may be recognised over the last 50 years (see Figure 2) but the full flow record for Kingston suggests a much more modest increase in high flow frequency.

This has implications for the sensitivity of return period assessments to the timespan of available datasets. Most gauging stations in the UK were commissioned in the 1960s or 1970s and in some regions no 50-year records are readily available. One consequence of the limited length of most flood series is that the recent cluster of flood events will have produced significant reductions in the return periods associated with high (if not extreme) flood flows in many catchments.

This merits further investigation. It also underlines the importance of maintaining updated and consistent flood databases, augmented where possible by historical data — normally less accurate, but still with great utility.

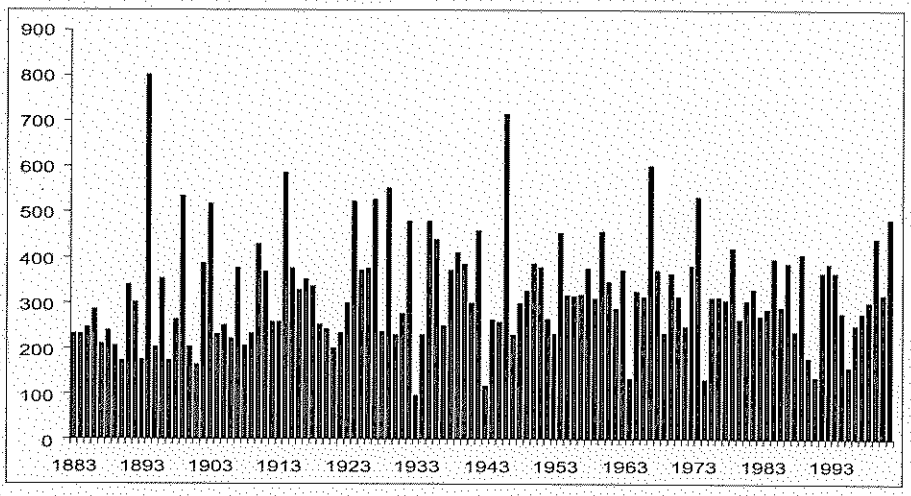


Figure 1 *Water-year daily maxima (in cumecs) for the Thames at Teddington/ Kingston*

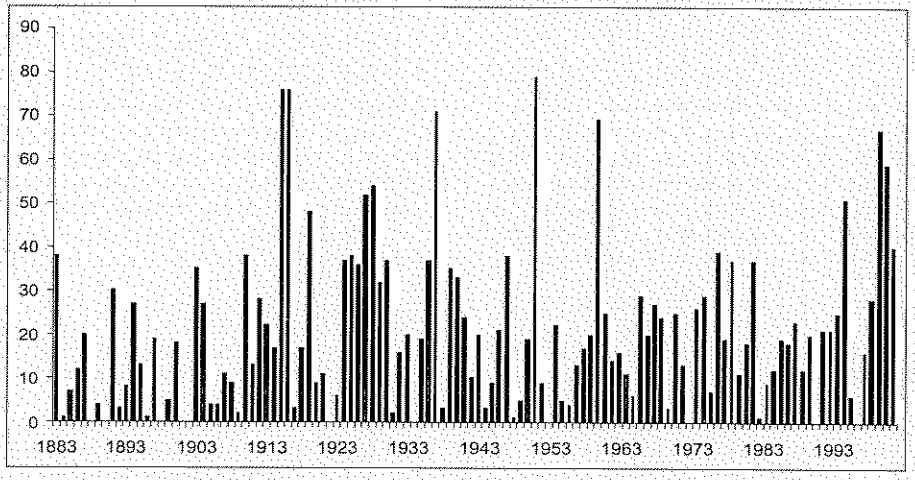


Figure 2 *Number of days with flows in excess of Q95 for the Thames at Teddington/Kingston*

Acknowledgement

This provisional appraisal of the 2003 Thames flood would not have been possible without the active cooperation of a number of Environment Agency Thames field and office staff: particular thanks are due to Paul Power.

Sources

Anon. 1948. The official story of the great floods of 1947 and their sequel. MAFF.

Howorth, B., Mowbray, B.E., Haile, W.H. and Crowther, G.C. 1948. The spring floods of 1947. *JIWE* **2**, 13-35.

Currie, I., Davison, M. and Ogley, R. 1994. The Berkshire Weather Book. Frogletts Publications (Westerham, Kent).

Griffiths P. P. 1983. A Chronology of Thames Floods. Thames Water.

Terry Marsh, CEH Wallingford

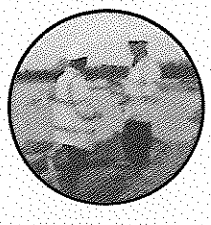
Hydrometric Register and Statistics 1996-2000

The latest Hydrometric Register and Statistics volume covering the period 1996-2000 is now available. Produced by the National River Flow Archive team at CEH Wallingford, supported by their British Geological Survey colleagues responsible for the National Groundwater Level Archive, it is the fourth in a series of reference works that have become indispensable handbooks both for practising hydrologists and a wide community of other users of hydrometric data. The principal aims of the publication are to document recent water resources variability, to assist data users in the selection of monitoring sites for particular investigations, and to allow more effective interpretation of analyses based upon the raw data.

Throughout the featured five-year period, river flows and groundwater levels displayed substantial and persistent departures from the seasonal averages. In many areas severe drought conditions extending from 1995-97 were superseded by a dramatic recovery in river flows and recharge rates culminating in the wettest 4-month period on record (Sept-Dec 2000), which triggered the most widespread flooding for over 50 years.

Hydrometric Register Statistics 1996-2000 includes maps, tables and statistics for over 1300 river basins and over 170 representative wells and boreholes throughout the UK. To this end, concise gauging station and catchment descriptions are given for the featured flow monitoring stations — particular emphasis is placed on hydrometric performance and on the net effect of artificial influences on the natural flow regime. Summary hydrometric statistics, for each of the years 1996-2000, are provided alongside the corresponding long-term averages, or extremes, to allow the recent notable variability in surface and groundwater resources to be considered in a suitable historical context.

The *Hydrometric Register and Statistics 1996-2000* costs £30 *(inc. p&p)* and can be ordered from **Felicity Sanderson**, cheques payable to NERC, or to pay by credit card please ring *01491 692202*, or we can invoice you if you quote an official order number. Please direct any email enquiries to *nwamail@ceh.ac.uk*.



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ENVIRONMENT AGENCY

MITCH workshop

Potsdam, Germany
24-26 November 2002

The third workshop under the MITCH (Mitigation of Climate Induced Hazards) EU Concerted Action, jointly organised by GFZ Potsdam and HR Wallingford, was entitled *"Floods, droughts and landslides — who plans, who pays?"*

The first day was taken up with an extended field visit to Dresden and Welsenstein, which had both suffered extensively during the floods of summer 2002. The River Elbe passes through the centre of Dresden, and many of the historic buildings in the old city had been damaged. In many places, cellars and ground floor areas were still being dried out by hot-air blowers on the day of our visit. A stop at the summer palace complex outside the city enabled us to see the wall marks of all major floods in the last 250 years: the 2002 event topped the previous peak by 10-12 cm.

The small town of Welsenstein lies in the deeply incised Muglitz River, a tributary of the Elbe rising in the Erzgebirge on the border with the Czech Republic. Clear-up operations were still much in evidence, as the river in flood had occupied most of the valley bottom over several miles, and had destroyed roads and some houses.

The workshop was divided into four main sections: risk identification and mapping; long-term spatial planning; emergency planning; insurance, public awareness and resilience. Examples of methods, projects and studies covering each of the natural phenomena were presented by 16 speakers, covering such diverse environments as lowland flood plains and high Alpine valleys. A persistent thread running through the presentations was the need to manage the social aspects of disasters, as much as the technical and engineering approach, to meet all high impact hazards. There were also over 20 poster displays of a wide range of research applications. The presentations generated considerable discussion, and there were break-out discussion groups covering four topics: risk assessment; stakeholder involvement; regional safety planning, and technology for local disaster prevention and management.

With over 40 people participating in the field visit and up to 80 in the Workshop sessions, it was considered that the meeting had been highly successful in achieving its objective of bringing together researchers and practitioners in a proactive atmosphere. Abstracts of all the papers, texts or summaries of presentations can be accessed on the MITCH website, *www.mitch-ec.net* .

An extension to the MITCH programme has been agreed to provide a one-day forum on aspects of the major flood events in Central Europe in 2002. This is planned for 6 March, to follow on directly from the EFFS meeting in Rotterdam. The programme is currently being finalised, but should include specialists from organisations directly involved with the events.

James Dent
MITCH Coordinator
HR Wallingford Ltd
j.dent@hrwallingford.co.uk

New members

A warm welcome to the following people who have joined the Society:

Lucy Ayers	Environment Agency, Bridgwater, Somerset
Lance W. Gore	Binnie Black & Veatch, Redhill, Surrey
Daniel Jimenez	Berlin, Germany
Dr Kate Marks	Symonds Group Ltd, Aylesford, Kent
Wendy A. Monk	Dept of Geography, Loughborough University
Fingal Noguera	Babtie Group Ltd, Glasgow
Jens Petry	University of Aberdeen
Joseph Pollacco	CLUWRR, University of Newcastle upon Tyne
Dr John M. Roberts	CEH Wallingford
Sandra Ryan	Environment Agency, Exeter
Helen Stanley	Environment Agency, Warrington
Tom Veitch	United Utilities, St Helens
Robert Waite	Environment Agency, Winchester
Prof. Paul Whitehead	Dept of Geography, University of Reading

Travel grants

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

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

The Exeter Fund, looked after by BHS, offers grants to help British hydrologists take part in IAHS events.

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

Publications

Open channel flow measurement

Contents of the special issue on **Open Channel Flow Measurement** in *Flow Measurement and Instrumentation* ***(Vol. 13 No. 5-6, December 2002)***:

R.W. Herschy: *Editorial to Open Channel Flow Measurement special issue*

T.H. York & K.A. Oberg: *Measuring river velocity and discharge with acoustic Doppler profilers*

A. Godley: *Flow measurement in partially filled conduits*

W. Boiten: *Flow measurement structures*

S. Dey: *Free overfall in circular channels: a method of open channel flow measurement*

J.D. Newman & J.D. Bennell: *A mountain stream flowmeter*

R.W. Herschy: *The world's maximum observed floods*

V. Weitbrecht, G. Kuhn & G.H. Jirka: *Large scale PIV measurements at the surface of shallow water flows*

S. Dey: *Free overfall in open channels: state-of-the-art-review*

M.-C. Lee, C.-J. Lai, J.M. Leu, W.L. Plant, W.C. Keller & K. Hayes: *Non-contact flood discharge measurements using an x-band pulse radar: (i) theory; (ii) improvements and application*

P.G. Holland: *The water framework directive*

R.W. Herschy: *The uncertainty in a current meter measurement*

R.W. Jones: *A method for comparing the performance of open channel velocity-area and critical depth flow meters*

T.J. Marsh: *Capitalising on river flow data to meet changing national needs – a UK perspective*

P.G. Holland: *The importance of glossaries*

F. Thomas: *Open channel flow measurement using international standards: introducing a standard programme and selecting a standard.*

Flow Measurement and Instrumentation may be purchased (price £250) from Elsevier at Langford Lane, Kidlington, Oxford, OX5 1GB *(tel 01865 843010)* or see the website *http://www.elsevier.com/locate/flowmeasinst*.

Papers from BHS members would be welcomed, especially on research. Please contact, in the first instance, Dr Reg Herschy, who is a member of the editorial advisory board *(email reg@herschy.freeserve.co.uk, tel 0118 947 9420)*

The Journal is on the ISI Citation list and therefore suitable for Continuing Professional Development purposes.

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HSJ contents listing

IAHS's *Hydrological Sciences Journal* ***(Vol. 48 No. 1, February 2003)*** contains the following scientific papers:

Demetris Koutsoyiannis: *Climate change, the Hurst phenomenon, and hydrological statistics*

Donald H. Burn: *The use of resampling for estimating confidence intervals for single site and pooled frequency analysis*

Rita Pongrácz, Istvan Bogardi & Lucien Duckstein: *Climatic forcing of droughts: a Central European example*

Sheng Yue, Paul Pilon & Bob Phinney: *Canadian streamflow trend detection: impacts of serial and cross-correlation*

Paul Christen Røhr & Ånund Killingtveit: *Rainfall distribution on the slopes of Mount Kilimanjaro*

Yeo Howe Lim & Leonard Melvin Lye: *Regional flood estimation for ungauged basins in Sarawak, Malaysia*

M. Yermani, K. Zouari, J. L. Michelot, A. Mamou & L. Moumni: *Approche géochimique du fonctionnement de la nappe profonde de Gafsa Nord (Tunisie centrale)*

Claude Michel, Charles Perrin & Vazken Andreassian: *The exponential store: a correct formulation for rainfall–runoff modelling*

Jean-Emmanuel Paturel, Mahaman Ouedraogo, Eric Servat, Gil Mahé, Alain Dezetter & Jean-François Boyer: *The concept of rainfall and streamflow normals in West and Central Africa in a context of climatic variability*

Plus reviews of two books:

Agricultural Nonpoint Source Pollution—Watershed Management and Hydrology edited by William F. Ritter & Adel Shirmohammadi, and

The Nile by Robert O. Collins.

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Members may use CEH Wallingford's Library by appointment *(01491 692266)*.

PhD thesis

Krypton as a tracer to quantify reaeration in surface waters

Jill Murphy has been awarded a PhD from the School of Civil Engineering, The Queen's University, Belfast for her thesis on *"The use of krypton as a tracer to quantify reaeration in surface waters"*.

The depletion of dissolved oxygen is one of the most common forms of surface water pollution. The main source of oxygen replenishment is the mass transfer of oxygen (reaeration) into the water body from the atmosphere. The rate at which this process occurs is defined by a coefficient for reaeration, K_2.

An experimental protocol was designed to use a stable isotope of krypton to quantify the coefficient for reaeration in rivers. The technique relies on the similarity between the gas transfer of dissolved krypton and oxygen in water. A radioactive isotope of krypton analysed using liquid scintillation counting had been used in previous reaeration studies but is no longer suitable due to current environmental legislation. The experimental

protocol was developed in a laboratory and tested in a river. In each experiment, krypton was released into the water alongside Rhodamine WT, and samples collected at two predetermined sampling points. The samples were analysed using Gas Chromatography Mass Spectrometry and fluorimetry. Reaeration coefficients were determined using two methods of calculation based on the assumption of one-dimensional flow.

The results, which are comparable with previous research, show that stable krypton is viable for use as a surface water tracer providing that the samples are collected after a period of full mixing in the river and that the experiment is carried over sufficient time to allow full tracer breakthrough curves to be established. Careful GCMS analysis is required in order to ensure that the concentrations of krypton recorded give an accurate representation of the actual tracer concentrations in the water. An assessment of the effect of experimental errors in the reaeration coefficient calculations, not accounted for in previous research, was made in order to determine both the viability and the precision of the experimental procedures and the calculated reaeration coefficients.

Chartered Geographer (CGeog) — a new professional qualification

The many members of BHS who have approached hydrology through a background in geography or a related discipline will be interested in the professional status of *Chartered Geographer*. The Royal Geographical Society (since 1995 merged with the Institute of British Geographers) has now been recognised by the Privy Council for the award of the CGeog status.

This qualification aims to promote the professional standing and recognition of the discipline of geography and its practitioners, and was awarded to the first cohort of recipients in *June 2002*. Chartered status can be gained by individuals who can demonstrate high levels of competence and professionalism in the practice in geography and related disciplines and who are committed to maintaining their expertise through continuing professional development (CPD). CGeog is available worldwide to those practising and enhancing their geographical skills and is recognised as a professional qualification throughout the European Union.

The qualification of CGeog can now provide a route to professional status for geographers working in hydrology, as an alternative to chartered status validated by institutions in engineering and water & environmental management. It is envisaged that the CGeog qualification will also be awarded in specific specialist areas within the wider discipline of geography, to be agreed by the RGS-IBG Professional Status Committee. The area of expertise will be indicated after the post-nominal CGeog.

For initial validation as a Chartered Geographer, applicants have to be Fellows (i.e. members, and all with an interest in geography over the age of 21 may join) of the RGS-IBG, and should hold an honours degree, at least second class, containing more than 60% geography, from a recognised higher education institution, plus a minimum of six years' practical experience (which includes periods of postgraduate training – the period varying according to degree), and have evidence of commitment to continuing professional development.

CGeog will be a useful professional status for people with an undergraduate background in geography and related disciplines, using geographical skills and knowledge in academic/scientific research and consultancy. The RGS-IBG is making the qualification available with modest initial application and annual renewal fees (£50 and £20 respectively), in addition to the annual subscription to the RGS-IBG (£75). Renewal is contingent upon evidence of continuing professional development, which can include conference attendance, presenting papers, or attending training courses relevant to professional expertise. Further details can be found at *www.rgs.org/charteredstatus*. **Dr Lorraine Craig** at the RGS-IBG *(l.craig@rgs.org)* or myself *(d.n.collins@salford.ac.uk)* are available for advice or discussion.

David N. Collins, CGeog
University of Salford

Recent advances in understanding river nutrients

BHS South-West Section Meeting
30 October 2002
Exeter University

This half-day meeting brought together three speakers from different centres in the South West of England to discuss their recent research on the important topic of nutrients in rivers. The audience of *ca.* thirty people was treated to three high quality presentations, which ranged across chemical, geographical and biological perspectives on different nutrient species, and encompassed new findings on state-of-the art instrumentation, hillslope/catchment linkages and in-channel processes.

In the first presentation, "Analytical techniques for the *in-situ* monitoring of nutrients in catchments", **Paul Worsfold** (Plymouth Environmental Research Centre, University of Plymouth) reported exciting developments in the instrumentation that can be deployed to capture detailed information on fluctuating nutrient levels in river systems. There is a need for high resolution temporal data on nutrients, such as PO_4-P, that are largely transported during infrequent high flow events. However, problems of rapid degradation of water samples subject to standard treatments, such as freezing or refrigeration, has stimulated the development of new instruments

capable of *in-situ* monitoring. Although such systems are faced with other challenges than those associated with laboratory determinations, especially relating to filtration, biofouling, calibration, validation and maintenance, there was significant progress based on the use of flow injection analysis.

Advantages of using flow injection include automated and reproducible presentation of samples, on-line physical and chemical sample treatment, speed, flexibility and low cost of analysis, automatic on-board calibration, and production of rugged but portable instruments. At the heart of the flow injection manifolds developed at Plymouth University (Figure 1) are robust, compact and cheap solid-state detectors based on bright LEDs which are focused onto photodiodes in a flow cell arrangement. The manifold can be modified to allow analysis of many different species of N and P including dissolved and particulate, inorganic and organic, and bioavailable and colloidal forms. Specialised tangential filtration and UV-digestion units have also been designed to allow dual channel sampling from turbid waters and analysis of organic P compounds. For work in estuaries and in the zones offshore from river mouths, submersible instruments equipped with salinity compensation to overcome the Schlieren or refractive index effect have also been developed.

A wide range of applications of the *in-situ* monitors had been developed at Plymouth. These included deploying submersible equipment in the North Sea to detect nitrate variations in the waters between the Humber Estuary and Dogger Bank, monitoring of phosphate in estuarine environments, studies of phosphorus species in the River Frome to validate catchment modelling based on export coefficients, and investigations of ammonia in landfill leachate. These were particularly novel, involving development of an integrated chemical and biological monitoring system, which allows parallel detection of physiological stress (via heart rate) experienced by crayfish (*Pacifastacus leniusculus*) exposed to the leachate.

Phil Haygarth (Institute of Grassland and Environmental Research, North Wyke) took us through what he described as an intellectual journey in his presentation on "Scaling up plot and lysimeter studies to assess impacts of contaminants on catchments", which reflected a growing catchment dimension to his research as a soil scientist. Transfer of N, P and pathogens from grassland systems provided the context for a conceptual linking between the field and farm scale, where perturbations affecting nutrient and contaminant transport occur, and large catchment units, where impacts on water quality arise and are subject to environmental legislation. Using the example of phosphorus, four 'tiers' or scales are involved in upscaling.

At Tier 1, the perspective is that of the agronomist interested in how agricultural inputs and outputs perturb the storage of P within the soil. Construction of P budgets for a typical dairy farm in South-West England (Table 1), for example, identify the potential sources of this nutrient. Phil identified mobilisation of P through mechanisms working at scales of centimetres to metres as constituting Tier 2 of the linkage between field/farm and catchment. Studies by IGER, using monolith lysimeters, small runoff plots and larger hillslope lysimeters, have investigated P mobilisation in a number of hydrological pathways and under different management scenarios. These have revealed the occurrence of chemical and biological solubilisation, whereby P is released from solid soil to solution, and detachment, mobilising P in particulate and colloidal forms. At Tier 3, the focus is on transport of P from the hillslope to the water course and particularly on the different forms of phosphorus involved and the many natural and artificial hydrological pathways that may be utilised. The last step in scaling up to understand the integrated impact on water quality (Tier 4) is the most difficult to tackle. However, the concept of the rate index (normalised maximum range of concentration / normalised maximum range of discharge) can usefully identify which hydrological pathways and pools of phosphorus are important in the transport at different scales in the landscape. In order to make further progress, interdisciplinary parallel/nested studies at different scales would be required, but it is also necessary to recognise the constraints of working at a particular tier within this continuum.

The final presentation by **Mike Bowes** (CEH Dorset) was on "Geochemical cycling of phosphorus in aquatic systems – retention and transport in rivers". Phosphorus was the major limiting nutrient in freshwaters, an important control on primary production and the main culprit in eutrophication, and Mike discussed the point and diffuse sources of P in river systems. CEH was particularly interested in the complex fate of P on reaching the river channel, where it can be transported downstream, bioaccumulated by flora and fauna, adsorbed to, or desorbed from, within-channel sediment, complexed with organic matter, or involved in precipitation reactions. Interactions between different forms (dissolved/particulate, organic/inorganic, reactive/unreactive) added further complexity to aquatic geochemical cycling of this nutrient.

Work was being done by CEH to understand P cycling at the large catchment scale of the River Swale in Yorkshire, which requires the difficult combination of extensive spatial coverage, intensive temporal collection and long-term commitment to monitoring. Consideration of the upland, transitional and lowland parts of the river system revealed that most phosphorus is generated in the lowland sector from sewage treatment works and intensive agriculture and is transported primarily in particulate form. Soluble unreactive phosphorus derived from acidic organic soils was more important in the upland zone, while soluble reactive phosphorus

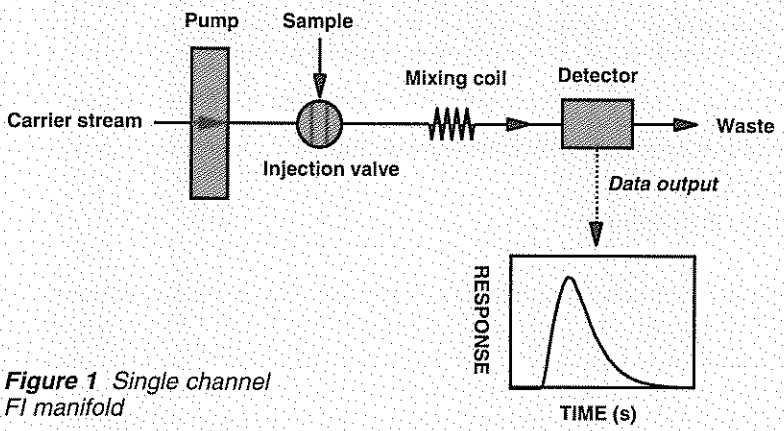


Figure 1 *Single channel FI manifold*

Table 1 *P budget for a 'typical' 57 ha dairy farm*

INPUTS	*kg TP ha⁻¹*	OUTPUTS	*kg TP ha⁻¹*
Feed concentrates	27	Milk	16
Fertiliser	16	Calves	0.5
Atmosphere	0.22	Transfer to Water	1
Total	~43	**Total**	~17

derived from sewage treatment works was more dominant in the transitional and lowland reaches. The seasonality of P transport also increased downstream, reflecting the increasingly dominant role of fine sediment in the process in the lower reaches.

Intensive mass balance studies of phosphorus storage and movement in the lowland sub-catchment based on detailed monitoring in a 55 km reach above Crakehill revealed different functioning depending on flow conditions. Under stable low flows (Figure 2A) there tends to be net P retention, reflecting deposition of particulate-associated P and bio-accumulation and adsorption to the bed sediment of soluble P. In many storms, net export of all forms of P was observed, reflecting re-suspension of bed sediment, release of P-rich pore-waters, and in-wash of soluble P from the floodplain. However, large retention of total phosphorus was recorded during a major overbank flood in March 1998 (Figure 2B), which reflects deposition of phosphorus-rich sediment onto the floodplain. Such results emphasise that rivers are not simply passive conduits for transport.

All three papers generated plenty of interest and discussion. Questions from the floor showed that there is scope for further work to advance knowledge of the applied and academic issues surrounding river nutrients, but the meeting closed with a feeling that much valuable progress has already been made through the research reported in the presentations.

Bruce Webb
Exeter University

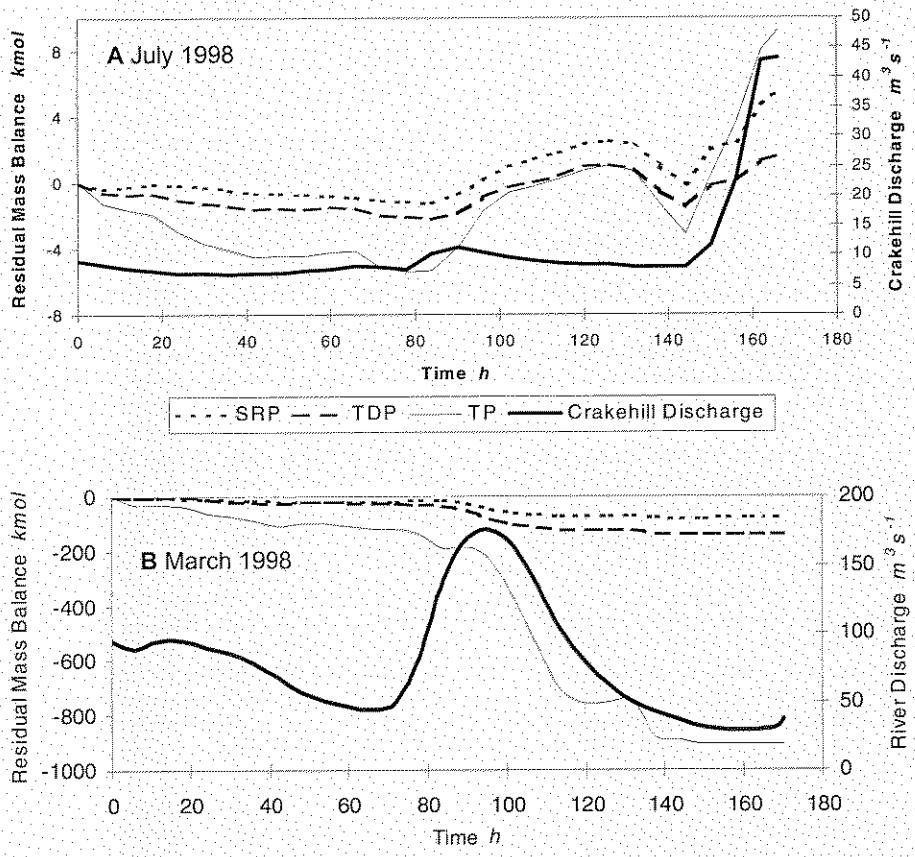


Figure 2 *Residual P mass balance in the lowland reach of the Swale above Crakehill*

Summit to sea — the value of Scotland's mountains and water in the 21st Century

Battleby, near Perth
20-21 January 2003

This meeting was organised by the Centre for Mountain Studies, Perth College, UHI Millennium Institute, in association with SEPA and SNH, as a contribution to the International Year of Mountains 2002 and the International Year of Freshwater 2003.

It was fitting that at the start of the International Year of Freshwater, following straight on from the International Year of Mountains, a meeting was held that addressed both the water and the land of Scotland's mountain areas together. Sixty participants from very diverse backgrounds met to discuss Scotland's upland waters: the current situation, trends, pressures and future directions.

On the first day, 11 speakers covered a range of topics reflecting the diverse factors that have an impact upon the upland water environment. These presentations provided a base for discussing management issues within a workshop format on the second day.

Following an introduction by **Alastair Findlay** (formerly North of Scotland Water Authority), **Geoff Burns** (SEPA) gave a presentation on Scotland's water resources and water supply, outlining the current state of Scotland's water environment. Based on an annual classification of river water quality that integrates water chemistry, biology and aesthetics, out of 24500 km of rivers classified, 87% are excellent, good or assumed good, whilst 13% are fair, poor or seriously polluted. A five-yearly classification of loch water quality, based on water chemistry and a comparison with estimated quality prior to human impact, reveals that 75% of the sampled lochs (all lochs greater than 1km^2 surface area, plus 27 smaller lochs) are excellent or good, with 25% classified as fair, poor or seriously polluted.

Moving on to the trends and pressures on the upland water environment, eight speakers addressed topics ranging from land use to fisheries, water supply, energy, recreation and erosion. **Charles Warren** (St Andrews University) began with a presentation on the trends and pressures of upland land use, identifying shifts from single

purpose to multi-purpose land uses; from sectoral to integrated approaches, as in the Water Framework Directive (WFD); from production to consumption; from bipolar to multiple ownership, and from hard science to "soft emotions" (in terms of decision-making). Charles pointed out that whilst there are many positive trends in this "age of consensus", great challenges remain, such as maintaining economic viability alongside environmental sustainability, actually delivering integrated management, defining objectives (what are the uplands for?), the future of agriculture, the mismatch of political versus environmental timescales and climate change.

The impact of fisheries on upland waters was summarised in the next two presentations. The first, by **Colin Bean** (SNH), outlined the current status of aquaculture in Scotland and its impacts on freshwater. Fish farming is a significant, heavily regulated industry in the Highlands and Islands, particularly for Atlantic salmon, rainbow trout, brown and sea trout, and to a lesser (but increasing) extent, cod, Arctic char and halibut. The main impacts on freshwater were identified as abstractions, discharge of waste, inorganic chemical compounds, fish escapes, loss of habitat and visual amenity. Colin concluded that the way forward for the industry was to increase collaboration, to improve in-house codes of practice and through the implementation of the WFD.

In the second presentation on fisheries, **Ronald Campbell** (Tweed Foundation) put forward aspects of natural fisheries for the tourism and leisure industry. He emphasised that the key selling point of natural fisheries in Scotland is quality, and said that this should be preserved by observing the limit on catches, and he advocated stocking only indigenous species in upland lochs. This may be in direct opposition to current anglers' demand and he concluded that much discussion between parties will be required to maintain the quality of the natural fisheries in upland Scotland.

A planned presentation on water supply by **Douglas Johns** (Scottish Water) had to be cancelled with apologies at the last minute. However, a conference participant, **Jim Cockburn** (formerly NoSWA) kindly agreed to fill the gap by sharing his experience in water supply in the Scottish uplands. Key aspects of water quantity are the balance between increasing demand, new resource development, conservation needs and efficiency of use, the impact of climate change on yield of and the impact of land-use change in upland catchments. Water quality standards will continue to get tighter, and this will mean more treatment which will have to be balanced against more catchment management.

The morning was rounded off by an informative and entertaining account of water as the raw material for the whisky industry by **Stephen Cribb** (an independent consultant). Whisky is Scotland's largest tax generator and export, with 900 million litres produced a year. A hundred malt distilleries each use their own water source, which is distinct in terms of water chemistry, and thus, it is thought, in flavour! Following a detailed description of the production process, he concluded that with approximately 4 litres of water required to produce 1 litre of whisky, the likely introduction of abstraction controls under the WFD will be of great concern to whisky distillers.

After lunch, the theme of "trends and pressures on upland catchments" concluded with three presentations on energy, recreation and erosion. **John Smith** (Babtie Group) began by reporting that trends of energy sources in Scotland had remained more or less constant over the last decade, with hydro-electric power generation supplying 10% and other renewables less than 1%. Government policies have set a target of 18% for renewable energy by 2010, with potentially 40% by 2020. John identified the impacts of renewable energy supply on freshwater and concluded that the inevitable growth of renewable energy will have impacts on the water regime, but that the balance can be delivered through the planning process, with a greater emphasis on ecological protection through the Water Framework Directive.

Fran Pothecary (Scottish Canoe Association), noting the integral relationship between water, mountains and recreation, began by reporting the relatively small percentage of Scotland's 6600 river systems actually used for whitewater recreation — just 215 runs on 195 rivers and burns. However, a Scottish Natural Heritage survey had shown that 25% of people had visited freshwater shores in the previous month. Whilst threats are apparent — such as loss of recreational sites, for example from the increase in proposals for small-scale hydropower schemes — there is also great potential for opportunities such as "freshet" releases, information about water levels on the internet, initiatives such as environmental river audits for the layman, and the delivery of cleaner river water through the WFD.

Finally, **Kath Leys** (SNH) reviewed the spatial and temporal trends in upland erosion and sedimentation and their implications for freshwater. Quoting a national survey which had sampled 20% of the Scottish uplands and found 12% affected by soil erosion, Kath reported that increasing erosion rates had been tempered by a reduction in the impact of forestry following the introduction of forest and water guidelines. Trends in slope processes indicated intermittent debris flow activity, particularly since 1700 AD, whilst very generally it could be said that rivers, alluvial fans and wandering gravel bed rivers have become rare in the last 200 years. The implications of these trends for freshwater range from blocking gravel in salmon redds, to isolation of sediment supply in managed rivers, leading to exhaustion effects and coarsening of the bed.

In the final session, three speakers addressed future directions for water management in Scotland, specifically in terms of flooding, river engineering and the Water Framework Directive. **Andrew Black** (Dundee University) began with a presentation on the management of flood hazard. Andrew emphasised that the management of flood hazard is complicated by the wide distribution of responsibilities, including riparian owners, different departments of local authorities, SEPA and the police. Noticeably absent from this list are developers and upland land managers. Recent research by Werritty *et al.* reported that climate change in Scotland could result in future reductions from today's 1:50 return period floods on some Scottish rivers (e.g. the Don and the Clyde), whilst others remain relatively unchanged (e.g. the Carron).

Andrew went on to present many options that could be implemented to manage such changes in flood hazard, ranging in scale and scope from better information for individuals, more structural defences, more wetland flood attenuation, development control, multi-functional reservoir management, more upland flood control reservoirs, changes in upland management, to emissions control. Specifically, upland options, such as land-use management, involve issues concerning the effects of drainage, grazing pressure and afforestation, for which more research is needed, whilst reservoir management, which may be technically feasible, may also be costly.

Trevor Hoey (Glasgow University), then addressed river engineering in Scotland's upland waters, reporting results from the River Habitat Survey (1998) which identified 47% of upland river channels (from a sample of 181) as being in pristine condition and 12% as obviously or severely modified. Scotland has a long history of small-scale river engineering, which affects river stability and ecology, and it was noted that whilst traditional, 'hard' river engineering has a place, alternative approaches are increasingly being considered wherever possible.

Thus while environmentally-based river engineering can contribute to the sustainable management of river systems, evaluation of costs and benefits requires the use of a whole-system approach. Finally river restoration and rehabilitation are increasingly on the agenda, and all

environmental disciplines need to contribute to the debate.

At the end of the day, and after many of the speakers had referred to the Water Framework Directive, the final presentation was by **Roger Owen** (SEPA) on the WFD and its potential for integrating at the basin scale. Starting with the scope and purpose of the WFD — to prevent deterioration and enhance status of aquatic ecosystems, to promote sustainable water use, to reduce pollution and to contribute to the mitigation of floods and droughts — the tight timetable of the Directive was highlighted. Key milestones are:

- by 2004, the river basin characteristics have to be described;
- by 2006 monitoring commenced;
- by 2009 the river basin management plans have to be finalised;
- by 2012 the programme of measures has to be operational; and
- by 2015 the objectives must have been achieved.

It is recognised that this is an immense task. Scotland will be represented as a single river basin district (RBD), with the Borders forming part of an adjacent cross-border district. River basin district advisory groups will be set up, which will incorporate stakeholder consultation, and river basin management plans (RBMPs) will be designed.

The success of the WFD will depend on an integrated approach with other planning authorities and forums, and on the participation of all interested parties. In conclusion, it was recognised that challenges lie ahead both for SEPA and for planning in delivering the considerable aims of the WFD.

Inevitably discussions during the day focused on the implications of the WFD, particularly on methods of public participation, methods of management and implementation and its success. This formed the basis of workshop subgroup discussions the following day on the five themes identified by participants in an "open space" format. The five themes were:

1 Hydropower compensation and other abstraction issues;
2 Overcoming barriers to integration between upland management and water management;
3 Science and facilitating participation;
4 Public participation in river basin planning;
5 Implementation of basin plans.

Their main conclusions, which inevitably overlapped, identified several requirements to facilitate success of the WFD and the management of upland waters:

- Early and wide consultation with improved communication, via openness, feedback, appropriate presentation of scientific methods and possibly a single source of public service information and advice for landowners/managers;
- Knowledge of how current strategic management processes are to be integrated, together with streamlining of current impact assessment processes;
- Hydrological and ecological monitoring to be better combined with the setting of ecological objectives, which must be transparent and based on risk assessment;
- A participatory approach is essential for successful implementation. River basin plans should be relevant to local people and pilot studies of how best to engage local stakeholders at the community level could be viable. Methods should use past successes of best practice and additional sources;
- Means and methods of implementation should be identified, e.g. who has power to make it happen, how are cumulative effects are to be dealt with, how to separate WFD requirements (compliance) from options requiring consensus, potential of scenario modelling;
- Resources are needed to ensure that adequate skills and resources are in place for a participatory approach and to facilitate participation of interested parties.

In closing the conference, **Drennan Watson** reiterated that when discussing changing the management of a resource, it is important to remember that it is changes in people's practices that are being addressed.

In an open summary, the conference participants concluded that there was a great enthusiasm for the opportunities that the WFD offers, that the WFD has enormous hunger for resources and that more integrated working is required. The diversity of views and expertise present at the conference had been very informative and apt in provoking debate and identifying ways forward with regard to upland water management. However, it was also noted that there is a need to reach a wider audience, such as landowners and farmers, who were absent from the conference.

Lindsay MacMillan
Perth College, UHI Millennium Institute

Launch of the IAHS PUB decade (Predictions in Ungauged Basins)

The PUB Decade is a major new initiative of the International Association of Hydrological Sciences (IAHS), led by IAHS President, **Prof. Kuniyoshi Takeuchi** of Yamanashi University, Kofu, Japan.

A three-day kick-off meeting in Brasilia, 20-22 November 2002, marked the formal beginning of the Decade. The overall objective of PUB is to improve the science that underpins estimation of hydrological variables in ungauged catchments. The value of ground-based data from *gauged* catchments, assimilation of data from remote sensing technologies, and better understanding gained from process field studies, will be major focal points. The issue of uncertainty in estimates of hydrological variables at ungauged sites will be a major issue.

The kick-off meeting was a mix of (a) discussion sessions concerning who could do what, how and when over the next ten years and (b) about 50 papers presented by delegates (in two parallel sessions). The papers can be seen under 'Communications' at *http://www.cig.ensmp.fr/~iahs/index.html*, where further information is available about PUB and the Brasilia meeting.

The Science Objectives for PUB are currently being prepared by the PUB Science Steering Group, chaired by **Prof. Murugesu Sivapalan** (University of Western Australia). Undoubtedly PUB is an exciting new initiative which will be of great interest and relevance to many BHS Members.

Following Brasilia there is much activity currently underway to set the PUB Decade in motion on a sound basis. The PUB Science Objectives will be presented at the World Water Forum (WWF3) in Kyoto in March 2003 and at a special session on PUB at the European Geophysical Union (EGU) conference in Nice in April 2003. Watch out for further information about PUB in future issues of *Circulation*.

Ian Littlewood, CEH Wallingford

Dissertations in hydrology

BHS Student Award 2003

★ First prize £400 ★ Two runner-up prizes of £200 each ★

The British Hydrological Society launched its annual Student Award in 2002 to promote the study of hydrology and raise awareness of the Society at undergraduate level. Prizes are awarded on the achievement, relevance, originality and presentation of submitted final-year dissertations addressing scientific and applied issues in hydrology, judged by a panel drawn from the BHS Main Committee.

The Societywas established in 1983 with the aim of promoting interest and scholarship in both the scientific and the applied aspects of hydrology. The Society hopes that this award will foster interest in hydrology amongst undergraduates and will encourage them to consider becoming student members of the Society as a means of developing their interest and exploring the potential for a future career in hydrology.

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

Dissertations must be submitted by **7 July 2003**. Further information about this competition will be sent to Heads of Department in April/May.

For further information about joining the Society or the Student Award, see our website at *www.hydrology.org.uk*. Student membership costs **£11** per annum.

For further information, please contact the Honorary Secretary, Dr Andrew Black, University of Dundee, *email a.z.black@dundee.ac.uk* or contact the Society at the Institution of Civil Engineers, 1-7 Great George Street, London SW1P 3AA, *tel 0207 665 2234, email bhs@ice.org.uk*.

What the Society offers

BHS is a registered charity run by an elected committee solely for the benefit of its members.

BHS holds regular national and regional meetings providing an open forum for the presentation and discussion of important current issues, studies, research, new developments and for the exchange of news and views.

BHS collaborates closely with all other UK organisations active in related subjects and promotes joint meetings.

BHS publishes a quarterly newsletter - ***Circulation*** - to keep members informed on British hydrological activities.

BHS membership is open to all individuals actively interested in hydrological work or research.

BHS encourages and supports attendance at national and international meetings through the provision of travel grants.

Diary of forthcoming events

3rd March 2003
BHS National Meeting with the Royal Met. Soc. — "Hydrometry in a changing environment"
Venue: ICE, London Time: 10.30
Contact: Andrew Black *(tel 01382 344433, fax 01382 344434, email a.z.black@dundee.ac.uk)*

12th March 2003
Scottish Hydrological Group AGM
"New hydro developments in Scotland"
Venue: G10 Rankine Building, Glasgow University Time: 18.30 *(tea at 18.00)*
Contact: Mike Cranston *(see above)*

16th April 2003
BHS National Meeting with the British Dam Society
"PMP and dam safety"
Venue: ICE, London Time: 10.00
Contact: Andrew Black *(see above)*

6th–11th April 2003
EGS/AGU/EUG Joint Assembly, Nice
(www.copernicus.org/egsagueug/index.html)

25th April 2003
Scottish Hydrological Group / Royal Met. Soc. (Scotland) joint meeting
"Floods in Scotland"
Venue: Perth (all day)
Contact: Mike Cranston *(see above)*

21st May 2003
BHS National Meeting with the BHS South West Section
"Hydrological uncertainty and risk"
Venue: Bristol University Time: 10.00
Contact: Dr Paul Bates *(tel 0117 928 9108, fax 0117 928 7878, email paul.bates@bristol.ac.uk)*

9th–10th September 2003
International Year of Freshwater — two-day event at CEH Wallingford
Contact: Rob Flavin *(tel 01491 692406, fax 01491 692424, email rwf@ceh.ac.uk)*

10th–12th September 2003
Aqua Enviro / CIWEM Conference
"The environment — vision, values and innovation"
Venue: Harrogate, Yorkshire
Contact: Alastair Chrisholm, CIWEM *(email alastair@ciwem.org.uk)*

Copy deadline for *Circulation* No. 77 4th April 2003

17th September 2003
BHS National Meeting and **AGM**
"Low flows"
Venue: ICE, London Time: 10.00
Contact: Andrew Black *(see above)*

12th November 2003
BHS National Meeting
"Water quality"
Venue: ICE, London Time: 10.00
Contact: Colin Neal *(tel 01491 692256, fax 01491 692424, email cn@ceh.ac.uk)*

12th–16th July 2004
BHS International Conference on "Hydrology: science and practice for the 21st century"
Venue: Imperial College, London
Contact: Dr Adrian Butler, Dept of Civil & Environ. Engineering, Imperial College, London SW7 2BU *(tel 0207 594 6122, fax 0207 594 6124, email a.butler@ic.ac.uk, website www.hydrology.org.uk/bhs2004)*