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TAY FLOODING: ACT OF GOD OR CLIMATE CHANGE?

The floods which swept Central Scotland in mid-January were significant both in a hydrological sense and in terms of the damage they caused. The recorded daily mean flow of the Tay on 17th January set a new UK record of almost 2000 cumecs, and in the process inundated hundreds of properties, great areas of agricultural land and caused millions of pounds worth of damage. However, they are also being seen to have much wider importance – as John Anderson of the Tay River Purification Board and Andrew Black of the Institute of Hydrology explain.

On Sunday 17th January the River Tay rose to the highest levels known in Perth since February 1814. Throughout the catchments of the Rivers Tay and Earn some 66 km² of land were inundated. Many small communities were isolated with farmland devastated and homes flooded. In Perth the city centre was badly affected by floodwater and the flood defences of the North Muirton Housing Estate were breached resulting in the evacuation of hundreds of residents. The primary factor behind this flood lay in the weather conditions of the preceding five days.

On Monday 11th January strong winds and heavy snow showers brought drifting snow across much of the Central Highlands and Eastern Scotland. These conditions persisted for several days and by 14th January there were large accumulations of snow extending across the catchments of the Rivers Tay and Earn.

By late evening on the 14th January heavy rainfall and temperatures rising to 4-5°C saw the beginning of a thaw particularly on ground below 450 m. In western parts of the catchment some 60 mm of rain fell overnight and by the morning of the 15th many of the smaller watercourses in the catchment were overflowing. Field and road drainage systems were fully surcharged and many small communities and roads were disrupted by localised flooding.

The rainfall eased during the day but much of the remaining snow, particularly at higher levels, had absorbed large quantities of rainfall and was in a very volatile state.

The morning of the 16th brought a further rise in temperatures to 10-12°C and rainfall totals in excess of 40 mm in



Figure 1 *When a flood is more than just a hydrological statistic — Charlotte Street, Perth, 17th January 1993*

the upper catchments. These conditions were sufficient to mobilise a rapid melt of the substantial quantity of snow remaining at higher levels throughout the catchment.

With all rivers running at high levels, as a result of the thaw and rainfall of the previous day, river flows rose to extreme levels over the evening of the 16th and into Sunday the 17th January. The River Tay Flood Warning System, developed by the Tay River Purification Board, received its first significant test since its introduction immediately following the last major flood in February 1990. Preliminary warnings were issued by the Board as early as Thursday 14th with the onset of the thaw and these culminated in the Red Warning for Perth issued at 19.00 hours on the 16th when the Regional Emergency Control Centre was told that serious flooding would occur in the Perth area on the following day.

The peak discharge of 2269 cumecs at Ballathie Gauging Station on the River Tay (Figure 2) was the highest in a record going back to 1952. The only other major floods in the gauging station record are the recent event in February 1990 when 1746 cumecs was recorded and a lesser event in January 1974 which recorded 1570 cumecs. Indications, from levels recorded on Smeaton's Bridge in Perth and from other historical sources, are that the January 1993 flood on the River Tay in Perth produced the highest river levels in the city since the flood of February 1814.

Of significance in this flood was the catchment-wide nature of the event with all major sub-catchments contributing substantial flows to the flood peak (Figure 3). The extensive nature of the Tay catchment, covering 4970 km² north of Perth and some 120 km from west to east, means that it is only rarely affected uniformly by any flood-generating weather system. Also important to the scale of the flood was the prolonged nature of the high flows. Flows were in excess of 600 cumecs on the Upper Tay at Pitnacree for over 15 hours and for over 22 hours on the River Tummel at Port-na-Craig. The peak discharges from the Upper Tay and Tummel catchments were virtually coincident at their confluence producing flows in excess of 1750 cumecs, which is nearly nine times the average January flow in the downstream reach.

An interesting feature of the flows from these upper reaches of the Tay and Tummel was that none of the major storage reservoirs (Lochs Ericht, Errochty, Lyon and Giorra) of the Tummel-Garry and Breadalbane Hydro-Electric Schemes spilled during the event and were able to continue storing water from their sub-catchments throughout the flood. At the confluence of these two rivers, less than 20% of the peak flow originated from above Loch Tummel, despite draining 47% of the catchment area (27% of the area above Perth).

Downstream of the Tay-Tummel confluence at the Caputh Gauging Station the peak discharge of 1874 cumecs was recorded at 10.45 on the morning of 17th January. Between Caputh and Ballathie Gauging Stations the River Isla adds its discharge to the Tay system and on this occasion was contributing in excess of 500 cumecs to the flood flow.

Immediately downstream of Caputh Gauging Station the Tay inundated a large agricultural floodplain covering 11 km² and in the lower reaches of the River Isla a further 18.6 km² of land were flooded. The attenuation afforded by this extensive area of floodplain was sufficient to delay the flood peak at Ballathie Gauging Station, which did not occur until 18.15 hours on the 17th, some 9½ hours after Caputh only 8 km upstream. Despite the attenuation available in these and upstream floodplains and the widespread overtopping of agricultural floodbanks the flood peak of 2269 cumecs at Ballathie was sufficient to cause extensive damage to the City of Perth.

Particular attention has focused on the January 1993 Tay flood because only 3 years have elapsed since the previous major flood. With the occurrence of these two recent events, the frequency distribution of annual maximum events at this station has changed drastically, in spite of what is a long record relative to most others.

Figure 4 shows two frequency curves based on a GEV-PWM analysis, produced with data from 1952 to 1989 and 1993 respectively. It can be seen that the magnitude of the 100-year flood has increased greatly over the four years from 1544 cumecs to 1991 cumecs, and conversely the risk of a 2000 cumec flood, which could again cause extensive inundation in the centre of Perth, has increased from being apparently once in much more than 1000 years to once in only 105 years.

Moreover, inclusion of informal Ballathie records dating from 1948

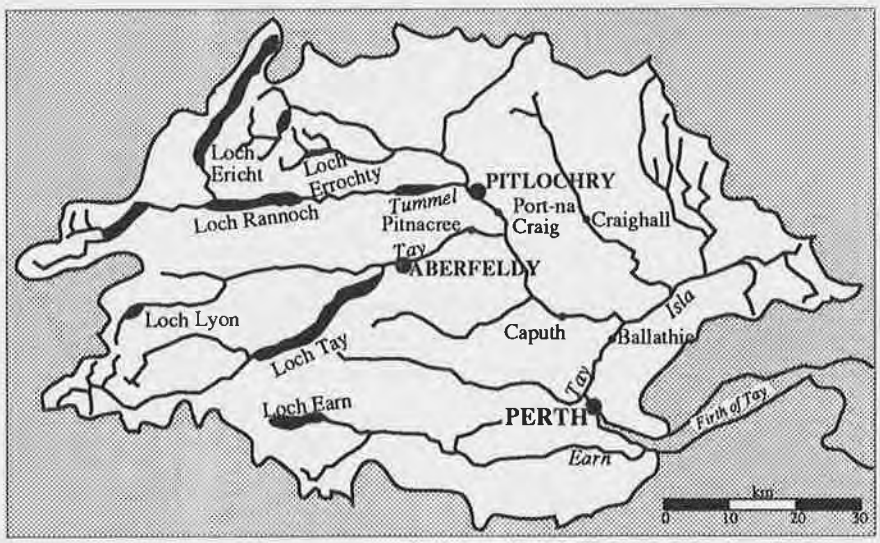


Figure 2 *Catchments of the Rivers Tay and Earn*

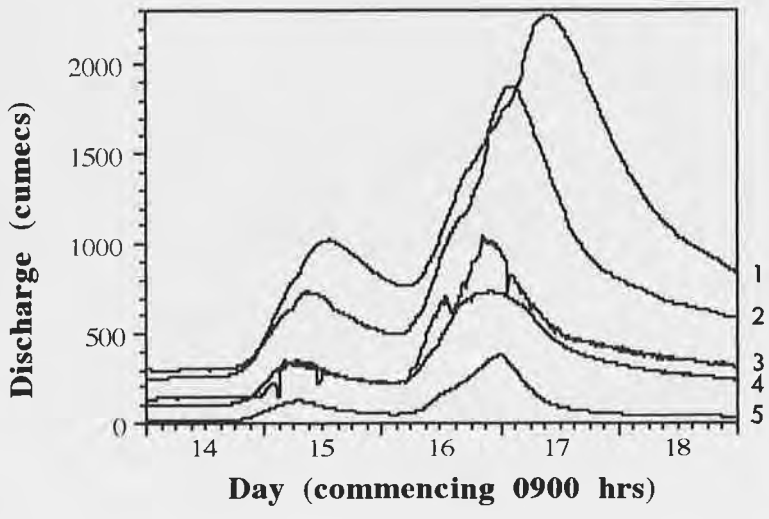


Figure 3 *January 1993 Tay flood hydrographs:* **1** *Tay at Ballathie,* **2** *Tay at Caputh,* **3** *Tummel at Port-na-Craig,* **4** *Tay at Pitnacree,* **5** *Ericht at Craighall*

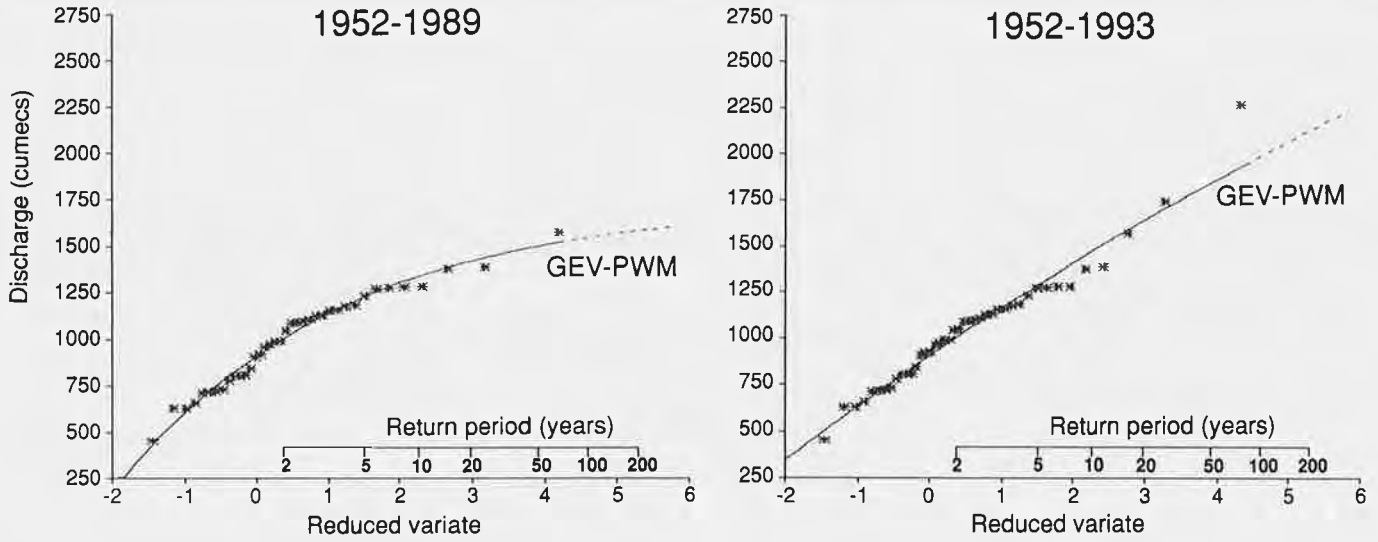


Figure 4 *Frequency curves based on GEV-PWM analysis for the Tay at Ballathie*

(producing a 46-year record to 1993) increases the apparent risk of a 2000 cumec event still further to once in 44 years. Details of the fitted distributions are given in Table 1.

Such spectacular shifts in flood quantile estimates highlight the dependence of statistical analyses on the period of record for which instrumental data are available. A 5- or 10-year flood can be estimated from the Ballathie record with a reasonable amount of confidence (i.e. low standard errors) but when addressing design floods of significance in damage terms, statistical estimates based on gauged records alone are still subject to considerable uncertainty. This is of great importance since decisions on flood protection works, often demanded after major floods, are based on such estimates.

To handle this problem, the UK *Flood Studies Report* recommended the use of historical information in addition to whatever gauged records might be available. This can add a meaningful context to gauged records, and can provide a guide to the likely suitability of a fitted frequency distribution at discharges in excess of the highest recorded values.

However, this approach still assumes that the flood series in question is stationary, i.e. the probability of a flood exceeding a given magnitude is invariant between one year and the next. Following the recent floods, great concern has been expressed regarding the possible effects of land use and/or climatic changes, and the occurrence of two such large floods in so short a period of time has provided powerful ammunition for those who place faith in these theories.

Recent events are in no way incompatible with the widely accepted understanding of flood generation as a stochastic process, but with the widespread concern which presently

Table 1 *Flood quantile variation with record used (Based on GEV-PWM fitting procedure)*

	Record length (*years*)	100-year flood magnitude (*cumecs*)	2000 cumec flood return period (*years*)	GEV parameters u	α	k
1952-89	38	1544*	(very high)*	915.1	262.1	.322
1952-93	42	1991*	104.7*	908.4	265.7	.054
1948-89	42	1897*	208.5*	932.5	286.4	.144
1948-93	46	2222*	44.3	936.6	290.8	.017

** Return period more than twice record length, i.e. considerable uncertainty in estimate*
Analysis performed with IH HYFAP frequency analysis package

exists – and no more so than in Perth – any attempts to identify trends are well justified. Perhaps the political process will ensure that some in-depth study is directed towards this issue in the context of the Tay's recent behaviour, but what follows here might at least raise some worthy questions in the meantime.

It is a matter of concern in many quarters that the winter runoff from at least some of Scotland's major rivers has been steadily increasing in recent years. Examination of the River Clyde record from 1958 (Blairston) certainly shows this, and the Tay shows a similar trend between the mid-1970s and the present (Figure 5). However, before that time the Tay shows a declining trend in its winter runoff, casting the significance of recent increases into some doubt. Nevertheless, it is striking that on both

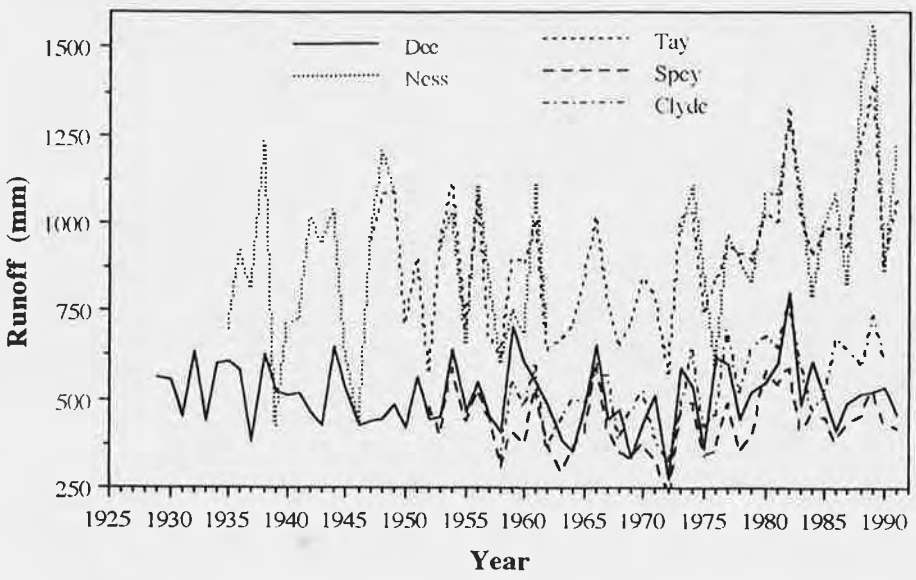


Figure 5 *Winter runoff in five major Scottish rivers*

the Tay and the Ness, for which 45 and 44 years winter runoff values are available respectively (though not over identical periods due to gaps), the 70 percentile winter flow was exceeded in every winter since 1977. A corresponding period of relatively dry winters in the late 1960s–1970s can be identified on the Rivers Spey and Dee, followed by higher flows, but the pattern is much more pronounced on the Ness and Tay.

Meaningful comparison with the Clyde is difficult because of its shorter record, but the data considered here seem to suggest that general increases in winter runoff over the last 15 years have been more pronounced in the north-west than elsewhere; changes certainly appear to be much more dramatic in north-west Scotland than in the north-east. The pattern may well represent an exacerbation of the existing strong NW-SE rainfall gradient across Scotland. Analysis of winter runoff data from the 130-year Loch Leven (Fife) record, while in the east of Scotland, also suggests that recent years have been exceptionally wet; detailed consideration of this particularly valuable record is to be published elsewhere.

By comparison, analysis of summer runoff data shows no easily detectable trend. Notwithstanding this, the winter data for the Tay must be seen to have some relevance to the recent floods which hit Perth, and flood series as well as seasonal runoff totals will need to be examined in much greater detail than has been possible here. However, on the basis of the data presented, the prospect of an increase in flood magnitude and frequencies does seem a real one at the present time, at least in comparison with the last few decades. Reasons for any trends identified will need to be established, but in the interim the possibility of changes in the Tay's flood behaviour must be taken seriously on the basis of existing evidence. Whatever the future may hold for the River Tay, research will be well-pressed to predict its behaviour but the need may never have been greater.

John Anderson, Perth
Andrew Black, Stirling

Hydrology of the Coastal Zone

BHS Southern Section Meeting
3 March 1993

Some fifty-plus members of Southern Section gathered at Imperial College, London for a meeting on coastal hydrology convened by *Sue Postle* (DoE) and *Ian Reid* (Birkbeck College, University of London). The subject was uncannily timely, with tidal flooding having hit parts of the East Coast two weeks earlier in a 'near miss' combination of high tide and surge that had made it necessary to raise the Thames Barrier, and with fears of the highest tide predicted this century due the following week.

The Meeting was chaired by **Edmund Penning-Rowsell** (Middlesex University). **John Pethick** (Institute of Estuarine & Coastal Studies, University of Hull) gave the first talk 'Non-linear effects of sea level rise on coastal zone flooding and erosion', pointing out the inevitable difficulties of attempting physical or computer modelling of the tidal prism. He then enthralled the audience by declaiming that estuaries were designed by nature to be inefficient - so reversing 20 years or more of philosophy inculcated by the unidirectional flow brigade! And his evidence is very convincing. For instance, John postulates that the morphology and hydraulics of tidal creeks are intended to dissipate flood-tide energy, not facilitate ebb-tide drainage. This is where isostasy and global warming impacts on eustatic sea-level come into the picture. The Essex marshes are sinking at around 4 mm a^{-1}, and have developed peculiar creek 'headwater' morphologies which John characterizes as "balloon end" and "Chelsea bun", in contrast with Irish examples where land/sea relations are more or less stable and where creek morphology is finger-like. Scaled-up, the impact of relative rise in sea level and the consequent residual energy of the tidal prism might be evident in the fact that the Blackwater Estuary had widened by about 1 km over the last 150 years. In the Humber, the long history of continuous embankment has inhibited similar morphological adjustment, so pushing the tidal prism further up-estuary and encouraging sedimentation. What is the solution? John gave several that are being, or will be, tried but without long-term success. His preference might be to remove the sea-wall and let the estuary get on with it!

Trevor Tanton (Institute of Irrigation Studies, University of Southampton) then gave Southern Section a serious but at times amusing look at 'Water relations and reclamation of marshes - the problems with salt'. The setting was the Hoo Marsh and the adjoining Isle of Sheppey. Much of these marshes have been reclaimed for agriculture but one local farmer, having at one time wanted to drain and reclaim, is now paid well to maintain the marsh as a SSSI. Salt marsh soils have a fragile structure kept intact by sodium both in the soil solution and saturating the ion-exchange sites of the organo-clay complex. Marsh in this condition drains well, and Trevor was able to show effective macropore by-pass flow as the reason. But, interfere with the natural drainage by installing subsurface drains and the salt level in the soil falls rapidly, thereby causing swelling of the clays and some deflocculation, and the downward spiral begins with vengeance. Natural drainage is now inhibited, the soil turns plastic (if not rheologically liquid), the field ponds, and the farmer is on a hiding to nothing. Trevor drew attention to the fact that the problem of saline soils is globally widespread and, of course, not just one of the coastal zone. The technical solution is application of uneconomic amounts of gypsum. Trevor's pragmatic solution is remarkably similar to John Pethick's — let Nature get on with it: she has a better maintenance track record than Man when it comes to saltings! — or mimic Nature more closely by designing surface drainage systems.

In discussion, **David Wardle** asked what impact the building of barrages would have on estuary dynamics and

sedimentation. John Pethick illustrated this with examples from the Netherlands and even alluded to the impact of the Thames Flood Barrage. The answer was that interference had to be matched by energy-absorbing compensation. **James Holt** alluded to the use of halophytes as a way of maintaining structure in saline soils. Trevor Tanton replied that arable agriculture was not an option on these soils without the prohibitive expense of soil amendments such as gypsum. And if cropping was economically infeasible, the marsh might as well be left alone. **Ian Reid** wondered if the Chelsea bun might be a part-product of the way the primary structure of the marsh sediments was controlling incision of the creek system rather than a commentary on the effects of residual tidal energy. **Richard Croft** asked why estuarine widening was accompanied by shallowing. John Pethick suggested that sediment was being transferred within the estuary and **James Dent** was able to confirm this in the case of accretion patterns at the landward end of Ganga-Brahmaputra delta estuaries in Bangladesh.

The Meeting closed with warm applause for both speakers, who were then pounced upon by members pursuing other points of interest. We were only sorry that **Sue Postle**, who has left for the Eastern seaboard of the USA, and marriage (our congratulations), was unable to be with us for this very successful meeting which she had helped to set up!

Ian Reid, Birkbeck College

The Derbyshire Derwent: Conflict and Control of a Managed River

BHS Midlands Section Joint meeting with IWEM
Loughborough University
3rd March 1993

The Derbyshire Derwent has historically been used by a multitude of conflicting interests. The Derwent Valley was at the centre of the industrial revolution and the demands for water usage were at times hotly contested. Today the Derwent is of great importance to the strategic supply network in the East Midlands. Major reservoirs together with river abstractions have resulted in a complex set of abstraction licence conditions and management control rules. Three papers were presented at Loughborough which illustrated the historical use of the river as a resource to the present day and the management options and tools for the future.

Dr Roger James, Principal, Catchment Management for the Lower Trent Area of the NRA Severn Trent Region, presented the first paper on the history and hydrology of the river.

The use of water to drive wheels, steam turbines, alternators and dynamos was discussed in relation to the industrial heritage of the valley. Today the surviving mills are being renovated for conversion into flats and many of the weirs along the river are once again being used in association with hydro-power generation.

Examples can be found at Peckwash Mill, where both flats and power generation are being considered, and at Belper Mill, where turbines have been installed to provide 400kVA with a maximum turbine throughput of 1100 Ml d^{-1}. The operations at Belper have been of concern to the NRA



over the last few years. However as the Licence of Right has recently lapsed the NRA are renegotiating with the mill owners to ensure that the new licence better protects existing abstractions.

The legacy of mining in the valley has left a network of soughs providing good quality water to the river. The Meerbrook Sough stretches under neighbouring catchments and eventually drains into the Derwent at Homesford where a reliable source of 48 Ml d^{-1} is abstracted by Severn Trent Water. The Magpie Sough provides a further 35-45 Ml d^{-1} to the River Wye, a major tributary of the Derwent.

Derby, the major city on the Derwent, is the location for a 100 Ml d^{-1} effluent discharge downstream of the city; 350 Ml d^{-1} is abstracted and returned to the river via the Courtaulds works. The river gauge in the city is used to tie in the majority of licences on the river with a prescribed average flow of 340 Ml d^{-1} and an instantaneous flow of 280 Ml d^{-1}. All major abstraction points are now measured and gauges exist in the middle reaches of the Derwent at Mytham Bridge, Belper, Duffield and (a new gauge) at Whatstandwell.

Paul Webster (Birmingham University) thanked Dr James for his presentation and enquired what he perceived as the major threats to the Derwent today. Dr James replied that the resource was quite robust, with adequate management systems to ensure reliability. Threats are more likely to quality rather than to quantity. **Malcolm Reeve** of Land Research Associates asked whether mine sediments created problems in the downstream reaches of the river, as they do in the River Swale in North Yorkshire. Dr James replied that isolated cases of cattle poisoning had been reported but the problem had not been perceived as great enough to be measured. **Cliff Dobson** (NRA Severn Trent) suggested that with the construction of Carsington and the renegotiation of the Belper licence the low flow problems on the Derwent would be greatly reduced. Dr James replied that drawdown of impoundments will always be a problem, especially at times of low flow. The Derwent Water Resources Model (*see below*) will still be needed for complete control of the river.

Richard Douglas and **Rod Wilkinson** then presented a paper entitled "Management of the River Derwent for public water supply needs".

Rod Wilkinson first described the history of provision of water from the Derwent catchment, from the installation of a pumping station on the river at Little Eaton in 1848 to the commissioning of Carsington reservoir in May 1992. By 1903 the Howden and Derwent dams were built to supply Sheffield, Leicester, Nottingham and Derby. By 1960 Ogston reservoir on the River Amber was supplying Chesterfield and the Church Wilne bankside storage reservoir on the Derwent was supplying Nottingham and Leicester. The addition of Ladybower reservoir to the Derwent Dam system and the construction of the pump-filled Carsington completed today's picture (see Figure 1).

Abstractions from the Derwent in the summer months are limited by the flows at Derby: with flows above 680 Ml d^{-1} at Derby, a maximum of 629 Ml d^{-1} can be abstracted from the Derwent. When flows drop to below 340 Ml d^{-1} the abstraction must be reduced to a maximum of 88 Ml d^{-1} and the compensation releases from Ladybower reservoir at the head of the Derwent must be increased from 39 to 75 Ml d^{-1}. However, abstractions can be artificially supported by releases from Ladybower and Carsington reservoirs.

The Derwent catchment provides 41 per cent of Severn Trent Water's raw water storage and supplies 22 per cent of the company's daily demand. However, the customers in the catchment itself consume only 10 per cent of total demand.

Richard Douglas continued the presentation, describing the Derwent Valley aqueduct and its link to the Severn catchment via the Avon/Soar link. The southern half of the link is supplied by the Severn and the north by the Derwent but the boundary between the two supply sources is flexible (see Figure 2).

Soft water from the Derwent Valley reservoir system is blended with the hard sough water to reduce corrosion problems in the aqueduct and to satisfy customer taste. The water from the Derwent Valley provides the cheaper option as the supply is gravity-driven. At Little Eaton, where pumping is required from the river to Church Wilne reservoir and where power is required in the treatment of the water, costs per megalitre are four times greater. However, as much of the Derwent water is exported to other catchments, the use of

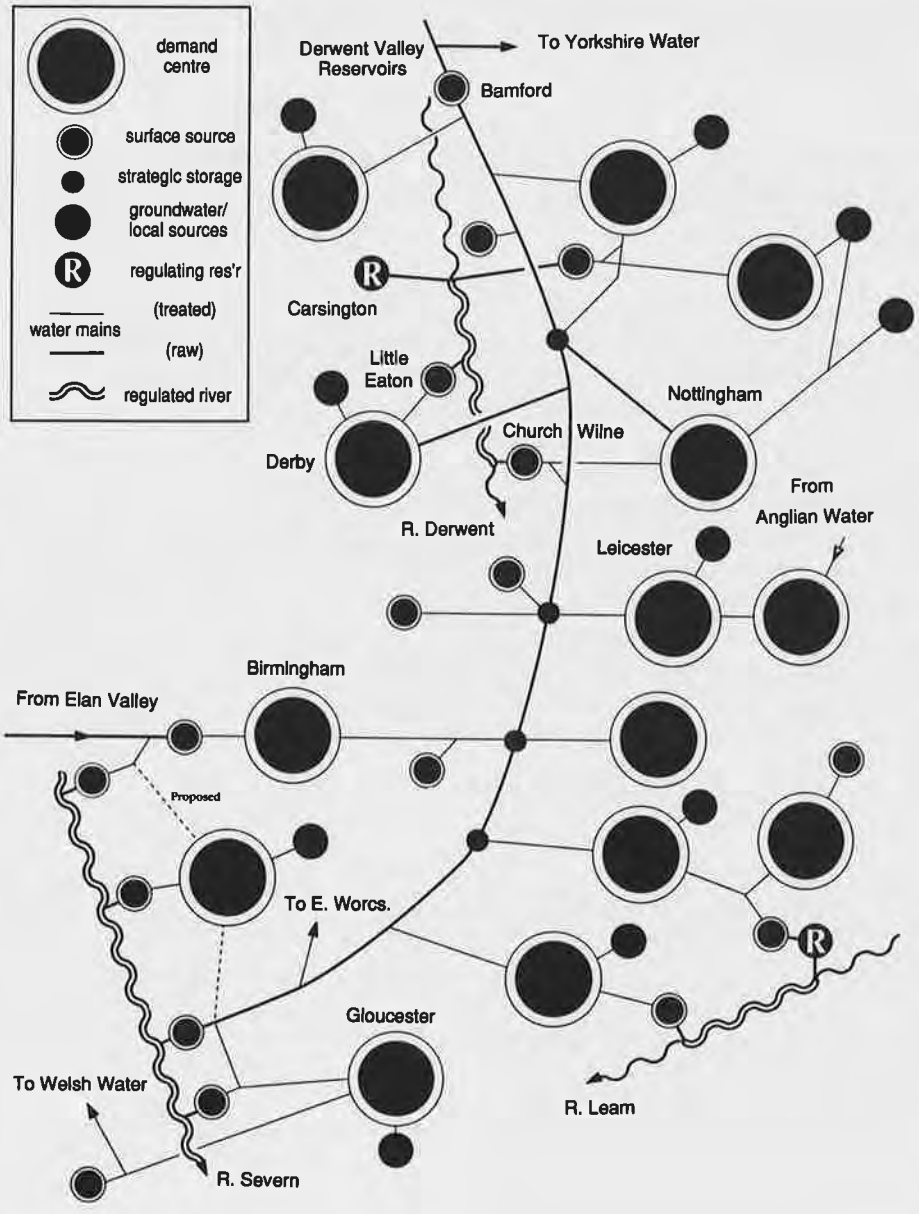


Figure 2 *Schematic supply diagram for the rivers Derwent, Leam and Severn*

Church Wilne water is not always minimised.

Mr Douglas highlighted three areas of potential conflict: pollution, non-consumptive uses and environmental problems. Pollution problems have been minimised by moving abstraction points upstream of major sources of risk. Most problems are due to turbid water after heavy rainfall. Non-consumptive uses such as HEP can confuse licences but environmental conflict has been minimised by the regulation facilities introduced by storage reservoirs.

Roger Goodhew (NRA Severn Trent) thanked the speakers and put forward the layman's view: as Derwent abstractions were 27% of the long-term average flow of the river, why were alternative water sources not used. Mr Douglas responded that all abstractions could be supported and were cost-efficient but he agreed that there was still a risk to flows arising from the variety of uses of the river. Cliff Dobson (NRA Severn Trent) asked whether the Derwent Valley reservoir control rules could now be relaxed because of the addition of Carsington reservoir. Mr Douglas replied that parts of the area still required Derwent Valley supplies so there was still some control needed. The Derwent Valley aqueduct also requires a minimum flow to keep the water sweet. **Barry Barton** (Anglian NRA) asked why the proposed groundwater schemes in the area had been abandoned. Mr Wilkinson replied that the scheme's abstraction licence had such tight restrictions that there was little benefit in its use.

Professor Peter Young of Lancaster University concluded the afternoon's presentations by describing the Derwent Water Resources Model (DWRM). The work was commissioned by the NRA to try to model the various uses of the River Derwent and provide forecasts at Derby and at other nodes for real-time and "what if" scenarios.

The model has been defined using data from the catchment and does not use a preconception of catchment processes. By using the data in this manner the modelled data rejected the Muskingum equation but lent themselves to the modified lag and route equation.

Using data alone, a rainfall runoff model was formulated which evolved into surface and groundwater components. Figure 3 shows an example of these two components from a recent paper by the presenter. An adaptive component of the model ensures that results are continually adjusted on a real-time basis by using a gain factor to account for errors. Professor Young controversially suggested that this implied that the majority of rainfall runoff models were over-parameterised.

The model has been refined to enable weir gate operations and their downstream effects to be modelled. This function will be of great use at Belper when telemetry is installed on the gate.

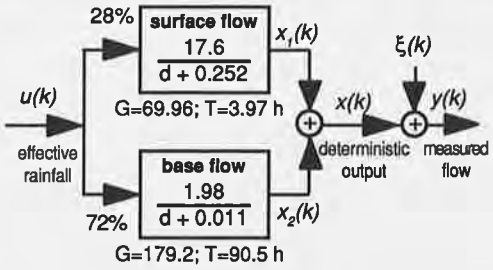


Figure 3 Data-derived surface and groundwater components of a model similar to the Derwent Watr Resources Model (DWRM)

Cliff Dobson (NRA) mentioned a recent MSc thesis (mine!) using gain factors to optimise the performance of a conceptual rainfall runoff model. He stated that the use of the gain factor was lost when data inputs are lost. Was this a problem in DWRM? Professor Young replied that if data were lost the ability to project them through the model was also lost, so there was no use for the gain factor in these circumstances. **Richard Cross** (NRA) asked whether the model constantly learned from the value of the gain factor to make calculations quicker and easier. Professor Young replied that the gain factor values were saved to memory and this memory was incorporated as an adaptive parameter in the model.

Richard Douglas (Severn Trent Water) asked whether results from the model could confirm travel times of releases from Carsington to the Derwent. Roger James answered that the model could be used in this way in real-time or by using the "what if" option. Both Dr James and Prof. Young agreed that the planned introduction of the further nodes into the model would improve calculations. The model could also be used for time of travel of pollutants (raised by **Alan Roe**, NRA) as advection and dispersion calculations were included. **George Parr** of Nottingham University asked whether the model was subject to any feedbacks but Prof. Young answered that these were not a problem.

The afternoon provided an exceptionally interesting session for all, whether familiar or unfamiliar with the River Derwent. The interest in the subject was reflected in the high attendance, over 100. As a hydrologist actively involved in maintaining flows in the Derwent, I hope to use DWRM to monitor the river in the coming summer. I can assure all the authors that they have not heard the last of my own dealings in the Derwent and I thank them for highlighting the complex water resource management of the river.

Richard Cross
NRA Severn Trent Region

New Members

We welcome the following members to the Society. The membership stands at 613.

Arshad, M. ..... Warwickshire
Bradley, C. ..... Dept. of Geography, Leicester University
Butler, A.P. ..... Dept of Civil Engineering, Imperial College
Calder, Dr I.R. ..... Institute of Hydrology, Wallingford
Callender, R.D. ..... Glastonbury, Somerset
Dale, A.G.J. ..... Travers Morgan, East Grinstead, West Sussex
Dale, J.M. ..... Islington, London
Dawson, R.J. ..... Peter Brett Associates, Reading, Berkshire
Fleming, S.E. ..... Yorkshire Water, Bradford, West Yorkshire
Gilman, K. ..... Institute of Hydrology, Plynlimon, Powys
Harris, W.B. ..... Penarth, South Glamorgan
Hughes, C. ..... Leeds, West Yorkshire
Lloyd, M.J. ..... Bristol, Avon
McAulay, S.L. ..... Acrefair, Clwyd
McKerchar, A.I. ..... Christchurch, New Zealand
Moore, D.N. ..... Ely, Cambridgeshire
Munnery, K.E.F. ..... Crawley, West Sussex
Oakeshott, Dr J.M. ..... Wardell Armstrong, West Bromwich
Price, D.J. ..... Institute of Hydrology, Stirling
Richards, M.C. ..... Coventry, West Midlands
Shepherd, G.W. ..... St Helier, Jersey
Simpson, K.A. ..... Chippenham, Wiltshire
Smith, A.J. ..... Southern Science, Worthing, West Sussex
Stephenson, M.R. ..... Oldmeldrum, Aberdeenshire
Thomason, D.I. ..... Upton, Wirral
Thorn, B.M. ..... Petham, Kent
Young, A.R. ..... Longdon, Gloucestershire

News from Members

Academic honours

Dr Susan Walker, President-elect of the BHS and Water Resources Manager at the NRA North West Region, has been appointed Honorary Professor in the Department of Civil and Offshore Engineering at Heriot-Watt University, Edinburgh.

Dr Howard Oliver of the Institute of Hydrology has been appointed to the Lectureship in Geography at Manchester College, Oxford University.

A new member, **Dr Ian Calder** of IH, who is also the Hydrological Advisor to the ODA, is to be a Visiting Professor in the Geography Department at Birkbeck College, London University.

Members on the move

After seven years working in Nepal and Bhutan, **Nick Mandeville** has just moved to Cambodia to act as Hydrology Programme Adviser to the Department of Hydrology in Phnóm Penh.

The project is entitled Management Support Programme and is funded by the Overseas Development Administration of the UK Government. There are two immediate objectives: first, to enhance the capacity of the Department of Hydrology to manage the development of the irrigation, flood control and rural water supply sectors, and second, to maximise the benefit to the Department of Hydrology from the current technical cooperation assistance being provided by a range of non-governmental organisations.

Nick may be contacted in Cambodia at: The British Mission to the Supreme National Council, Fax: 010 855 2327125, or by mail to Dr A N Mandeville, FCO (PHNOM PENH), King Charles Street, London SW1A 2AH.

Movements at the NRA

Management in the North West Region of the NRA has recently been reorganised, with the formation of three multi-functional operational areas and a regional policy, planning and performance monitoring unit.

Peter Walsh has become the Northern Area Manager, based in Carlisle, while **Sue Walker** will be responsible for Water Resources, Flood Defence and Fisheries, Conservation and Recreation in the regional unit based in Warrington.

The President's Piece

Change of Secretary

After many years of supporting the Main Committee and the Society as our Administrative Secretary, ICE's **Peter Bacos** has been moved away to serve the Energy Board and its associated societies. We all wish him well in this and welcome **Louise Picton** in his place.

The re-structuring at the Institution has grouped related subjects together: Louise looks after the ICE Water Board as well as BHS, the British Dam Society, ICID, and liaison with IWEM. This is a welcome step and should help with collaboration in joint meetings. From a selfish point of view, it would have been good to include IAHR too, but that has been bundled with 'Maritime' rather than 'Water'. However, both these areas still come under our old friend **Norman Tyler**.

Personal

My own address details in the previous issue were incomplete: please add 'Watlington, Oxfordshire OX9 5NT', and the fax no. has changed. I have at last found an efficient way to combine fax and 'phone on the same line, with just one number: 0491 612581. It took a while to research the market and find something which handles incoming automatic faxes and a) rings the 'phone normally when it is a voice call, b) does not ring for a fax and c) has no annoying electronic voice. I use my computer with a fax modem: if anyone would like to know which particular 'gizmo' does the trick, please give me a call.

Independent consultants' register

Despite a reminder, most of the 91 members who expressed an interest in being included in this listing continued to be shy when the crunch came. Perhaps that was just as well, because it has taken long enough to process the details of the few who did send in their mini-CVs. The Register has now been completed and is being checked by the members featured. Distribution as a Handbook component, and availability to external enquirers, will begin shortly.

Information from members

Less than a third of you discovered, completed and posted the form which was enclosed with *Circulation 37* requesting extra details for the membership listing. In the hope that many of you will respond if pressed, we have included it again. Please fill it in. It will not take long and it really will make the Handbook more useful to all.

Reciprocal membership

The latest Societies to enter into reciprocal membership with BHS are the **Hydrological Society of South Australia**, the **American Institute of Hydrology** and the **Netherlands Hydrological Society**.

South Australia

The South Australian Society has 200 members from all sectors of the water industry in the state. They produce four newsletters a year and hold bi-monthly meetings and occasional seminars. They offer to assist visiting BHS members: write to P D Harvey (Chairman), The Hydrological Society of South Australia Inc., c/o Water Resources Branch, Box 1751, Adelaide, SA 5001. The South Australians are also hosting the next International Hydrology and Water Resources Symposium of the Institution of Engineers Australia in November 1994. To be called **'Water Down Under '94'**. This will be combined with the 25th Congress of the International Association of Hydrogeologists and should be a major event.

USA

The American Institute of Hydrology (AIH) is a very different body from our own Society and, as far as I know, from

any of the other Societies with which we are linked. It was established in March 1981 (just a year before us!) to:

- enhance and strengthen the standing of hydrology as a profession and
- establish procedures for certification of competent individuals qualified in any field of hydrological sciences.

While we certainly seek to do the former, we have confined our interest in certification to exploring ways in which other Institutions (ICE, IWEM, Royal Met. Soc., Institute of Geologists) can provide routes to chartered status. This is not to say that we will never develop our own procedures, but widespread support for the idea of a British 'Chartered Hydrologist' is currently lacking. The Americans claim to be responding to increased public interest in assessing the professional competence of those whose activities affect them. The demand for certification was also partly driven by employers, who want standards against which applicants can be measured.

The AIH certification programme combines peer review, appraising educational background, professional experience and professional conduct, with a professional examination. Applicants must be graduates with at least eight years working (or studying) in hydrology after completing their first degree. They must also produce evidence of an original investigation which has been published and produce five referees to confirm their history and testify to their integrity and conduct. The examination tests their understanding of basic principles and their ability to 'sort out meaningful data and to apply hydrological/hydrogeological analysis to practical problems'. If successful, the applicant is certified as a Professional Hydrologist or Hydrogeologist. The certificate is renewed annually (for a fee, one imagines!) and – this is unusual – re-certification is done every five years.

The AIH holds annual meetings with technical conferences, runs short courses, publishes a quarterly newsletter (the *Bulletin of the AIH*) and also a quarterly journal (*Hydrological Science and Technology*).

AIH are actively seeking to recruit members, and encourage certification, from outside the USA. Among their 1000 members, they have some in 37 other countries and have recently set up European and Mediterranean 'Chapters'. I have a fuller statement of their aims and activities which I can supply to anyone interested. For even more details, members could contact the Regional Corresponding Secretary for the AIH European Chapter, Bob Aldwell, Geological Survey of Ireland, Haddington Road, Dublin 4, or the General Secretary of AIH (Dr Alexander Zaporozec, 3817 Mineral Point Road, Madison, WI 53705, USA.

The reciprocal arrangements between AIH and BHS comprise mutual promotion and publicity for meetings as well as exchange of newsletters. We look forward to cooperating with them in the future.

Netherlands

Compared to the AIH, the Netherlands Hydrological Society has a more informal structure and approach. The emphasis is on meetings and activities to keep Dutch hydrologists in touch with each other and with international developments (e.g. courses, symposia, etc.). Their membership fee is only £5 — to cover the cost of producing and posting their quarterly newsletter. This runs to 40 or 50 pages but comprises, for the most part, photocopied handouts and reports. They hope to raise the editorial and printing standards in future. They are interested in possible bilateral meetings and this will be followed up. In the meantime, members may like to know that the President is Dr W Cramer, Bateweg 55, 2481 AM Woubrugge, The Netherlands (Tel: 31-70 339 4252).

Mike Lowing

GROUNDWATER PROJECTS – OMAN

AKER ENGINEERING plc is a major international contractor, providing engineering expertise worldwide. We require staff, for forthcoming projects in the Sultanate of Oman, who have experience in groundwater exploration, assessment and exploitation in arid zones. The contract periods are twelve months, with 48 days leave per year. All positions require a degree in geology, hydrology or engineering, with specialised experience as follows:

Senior Hydrogeologist:
Minimum of 10 years experience with at least 3 years at Project Manager level, familiar with computer analysis techniques.

Field Hydrogeologists: (3 required)
At least 5 years experience, to include data collection methods, use of data loggers and presentation of field data.

Well Site Geologists: (4 required)
At least 5 years experience of computerised data collection and reduction techniques using loggers.

CVs urgently by fax please, quoting Ref. 260, to **071-371 7870**

Aker Engineering

AKER ENGINEERING plc
Bedford House
69-79 Fulham High Street
London SW6 3JW

Help with attending scientific meetings

As previously described by the Hon Treasurer, the Committee has decided to use some of the interest generated by our capital reserve to help members attend meetings which might otherwise be beyond their reach. The scheme will be open to anyone, but it is intended principally to help students or younger members whose travelling expenses are not met by an employer. Grants will be in the range £75-£100.

Applications should be sent to the Hon Secretary (**Richard Harpin**) and should include details of the meeting, whether or not a paper or discussion is to be presented, the total costs and benefits of attendance, and brief details of your financial situation, your background and aspirations in hydrology. A brief supporting letter from a supervisor is also required. Applications should be received by *1st July* for help with attending the Cardiff symposium. Successful applicants will be expected to produce a short report of their experiences in attending the meeting.

Occasional Paper No. 4

Would you, as a practising hydrologist, like a single book you could turn to which, at the very least, would get you started on almost any problem you are likely to encounter? Of course you would! Well, you will be pleased to know that such a book is about to be produced. You might not be *quite* so pleased to learn that if you want it you will have to help write it! Well not exactly, but we (the BHS committee) *do* need your help.

The BHS has produced a series of occasional papers dealing with hydrological topics: *Occasional Paper No. 3* is in its final stages of pre-publication editing. We are now considering what paper No. 4 should cover. The idea we are working on at present is a "Hydrologist's Workbook"

This "workbook" would contain as much as possible of the basic methodology hydrologists use, but in a very succinct form. Most of it would consist of formulae, tables and figures which one would normally find in hydrology textbooks as well as in books on statistics, hydraulics etc. Each topic would be covered in one or more of the following ways:

- A short description of the methodology, usually not longer than a paragraph.
- The basic formula used.
- Numerical solutions or approximations if the formula cannot be used directly.
- A graph of values.
- A table of values.
- Cross references to original papers and/or textbooks for a more complete description.

This method of presentation would satisfy a range of needs: the formulae would be useful if you were writing your own programs; tables would enable you to get an accurate result for a particular range of values; on the other hand graphs might allow you to interpolate, perhaps with less precision than in the tables. Often the "workbook" would contain all the information you need, but by giving references you would be able to obtain more detail if you needed it.

The book would be of use to hydrologists who have access to library facilities, but also, of course, to hydrologists who do lot of their work away from libraries and cannot travel with a lot of heavy books. In the former case it would serve as a place to look for outlines of methods before delving more deeply into the reasoning behind them, their advantages and disadvantages. In the second case it would enable a hydrologist in the field to have access to information normally spread over several books.

We have drawn up a provisional contents list which is as follows:

Section 1 - Hydrometeorology
World's water in oceans, lakes etc.
Global water balance
Constituents of air
WMO guidelines on raingauge density
WHO water quality guidelines
World extreme precipitations
UK and other countries extreme precipitations
World extreme discharges
UK and other country extreme discharges
Vapour pressure/temperature
Radiation for different latitudes and months
Formula – wind speed/height
Energy formula for Penman
Penman (PET)
Thornthwaite (PET)
Bell's formula (duration/intensity)
Storm profiles (FSR, SCS etc)
Figure of precipitable water as a function of dewpoint
Hershfield formula
Table of worldwide gev parameters

Section 2 - Hydraulics and routing
Manning's formula
Table of Manning's n
Saint-Venant equations
Velocity of kinematic wave
Velocity of dynamic wave
Jones formula loop rating curves
Weir formulae
Underflow gate formulae
Channel expansion and contraction formulae
Kirpich and other formula for time of concentration
Unit hydrographs – formulae for proportion of runoff
Muskingum flood routing formula
Critical flow velocity
Froude number
Allowable tractive forces in different bed materials
Angle of repose of non-cohesive materials

Section 3 - Statistics
Standard deviation
Linear regression
Correlation coefficient
Standard error of estimate
Plotting positions (Weibull, Gringorten)
Gumbel EVI formula
Gumbel EVI table of values
Gumbel EVIII formula
Gumbel EVIII table of values
Normal distribution formula and table
Gamma distribution – table
Pearson type III – formula and table
Table of Pearson III coefficients
Table of outlier tests
Normal probability tables
Table of Chi-squared
Student's t
Polynomial approximations to statistical formula
Figure - risk of exceedance of design event in design life
Table of reservoir flood standards

Section 4 - Soils and groundwater
Thiem equation (borehole yields)
Theis equation (borehole yields)
Soil particle size classification
Permeability for different materials
Horton's infiltration equation
Table of values for Horton
Phillip's infiltration equation
Formula Soil moisture/effective permeability

Section 5 - Mathematics
Unit conversions
Tables of integrals
Volumes and areas of spheres, cones, polygons, etc

As I said above, this is a provisional list, and we now need your help. Firstly we want the book to cover as much ground as possible so can you suggest either any extra sections or any additional topics within the above sections? You might even want to suggest a different arrangement of sections.

Secondly can you let us know what you think of the idea? We believe that the idea has a lot of potential and would produce a very useful book. We also recognise that it would take of lot time and effort to produce and obviously would not want to undertake this if it was not going to be bought and used by a lot of our members and others.

If you have any ideas, comments, suggestions or offers of help then please write to:

R E Manley
78 Huntingdon Road
Cambridge CB3 0HH.

Publicising members' books

We will be compiling a list of BHS publications — with details of availability and ordering information — for intermittent inclusion in the member's handbook. The committee thought it would also be useful to include books written or edited by BHS members. This is seen as a service to the authors and to members generally. It is *not* seen as a step towards free advertising by members. Will any member who would like their book(s) listed please send all the usual details (Title, edition, date, price(s), ISBN, publisher, etc.) to the Editor (see back page for address).

BHS Research Sub-Committee

As a result of a number of discussions within the hydrological community on the need for a stronger presence for hydrological research, both within and outside the research Council framework, a Research Sub-Committee of the main BHS Committee has been formed, under the joint chairmanship of **Frank Law** and **Howard Wheater**.

The broad aims of the Research Sub-Committee are to promote and strengthen the role of hydrological research, and to respond as necessary to the Government Science White Paper which is due this summer.

The first meeting of the Sub-Committee was held on 14th April, and it was agreed that a strategic review of hydrological research should be produced, which would introduce the role of hydrological science in environmental management, review current organisation and funding of hydrological research, and focus on a number of potential research initiatives. These initiatives would be of key scientific importance and suitable for promotion as relatively large-scale research topics, probably under a community funding scheme.

The Sub-Committee would welcome views on suitable research areas, with a nominal target funding of up to £5 million per annum for 3-5 years, and a brief indication of how the scientific justification and potential application could be presented. If you would like to suggest possible areas, please contact **Frank Law**, Institute of Hydrology, (Tel 0491 838800, Fax 0491 838097) or **Howard Wheater**, Dept of Civil Engineering, Imperial College (Tel 071 589 5111 ext 4736, Fax 071 823 8525) before *July 5th*.

Royal Met Soc Accreditation Scheme

The Royal Meteorological Society have now finalised their scheme of accreditation, so the route to *Chartered Meteorologist* status is now available to suitably qualified *BHS* members.

The Royal Met Soc are positively welcoming *BHS* members who have some academic training in meteorology (e.g. meteorological modules within a Geography or Environmental Sciences degree) as well as a career in hydrology.

In order to apply it is necessary first to become a member of the Royal Met Soc. Then forms detailing training and experience must be submitted and a professional interview will normally be required.

Information packs which explain the process and the qualifications required by applicants can be obtained from The Royal Met Soc, 104 Oxford Road, Reading, Berkshire, RG1 7LJ.

Sue Walker and the BHS Education & Training Subcommittee would be interested to hear from anyone attempting this route to Chartered status in order that they can gauge whether there are any difficulties which need to be taken up with Royal Met Soc. Be patient, though! They say that the accreditation process may be slow in the first few months of the scheme as they have to deal with the backlog of members of Royal Met Soc who are taking up the option of Chartered status at the earliest opportunity. If application is made before *31 July 1993*, this is at the special introductory rate of £85, compared with approximately £125 after this date. The annual subscription must accompany any application from non-members of Royal Met Soc.

Flood Studies Report

Now available again following a second reprint*, this definitive reference work on flood estimation techniques looks set to remain on IH's publications lists for some time to come. Although there have been many developments in flood hydrology during the period since 1981 when the first reprinting took place, the basic philosophy of the *FSR* remains unchanged and sales of the *Report* remain constant. In this new binding, the opportunity has been taken to bind all 18 of the *Supplementary Reports* into the main volumes and the 1983 list of *Some papers of interest to Flood Studies Report users* has been extended through a new bibliography of papers covering the period 1983 to 1992. In addition, new purchasers will receive a numbered voucher worth £100 off the price of the IH computer package *Micro-FSR*.

* from the Librarian,
Institute of Hydrology, Wallingford,
Oxon, OX10 8BB, price £150.00 + p.&p.

A reminder!

Enclosed with this issue of *Circulation* is another copy of the form sent out last time requesting information from members.

If you were among the majority who did not return the first form, please will you complete the new one and return it promptly to the address given on it.

Committee corrections

Please note the following corrections to the BHS Committee list printed in *Circulation 37*:

The President's own address was incomplete - please add 'Watlington, Oxfordshire OX9 5NT' – and his fax no. is now the same as the telephone: 0491 612581.

Susan Walker's home telephone number is now 0928 733767.

The **Institute of Hydrology** now has 6-figure numbers beginning with 8: Telephone 0491 838800, Fax 0491 832256. This applies to all Wallingford numbers, so home numbers are also changed: **Frank Law** 0491 836443; **Celia Kirby** 0491 837677.

As reported in the President's Piece, the Secretary to the Main Committee is now **Louise Picton**: Tel. 071 839 9836; Fax No. as before.

An updated BHS Committee list for the Member's Handbook is also enclosed with *Circulation*.

BOOKS

Water use of forests

The Growth and Water Use of Forest Plantations, Calder, I.R., Hall, R.L. and Adlard, P.G. (Eds) 1992. John Wiley & Sons (Chichester) ISBN 0 471 93561 1, Hardback, 375pp. £40

This volume, edited by specialists in the subject, presents a well produced set of 30 papers from the 1991 Symposium at Bangalore. The papers summarise and discuss an ambitious set of field experiments in Karnataka, backed by laboratories both in India and in England and funded by the UK Overseas Development Administration.

The field studies sought direct answers to the much-debated questions of the water-use of *Eucalyptus* species and their effects on adjacent vegetation. Some very effective evidence has already been produced, but a greater range of seasons and further growth of young plantations will be needed for a final verdict. There are answers already to some of the myths which have been debated for half a century with much rhetoric and few measurements. Since *Eucalyptus* species are used in more than half of all plantation forestry in the tropics this is indeed a subject of acute practical importance.

The papers are not confined to Karnataka: results are contributed from studies in forest water use in Australia and South Africa as well as from ICRISAT and other research institutes in India. Before getting down to the details

of measuring and modelling there are six papers on the policy issues of land-use, the social implications of promotion by industry of eucalyptus growing by private farmers and the role of Forestry Department management of State Forests.

To anyone who has seen the contrast between the grim unproductive poverty of the wastelands of India and their productivity under fast-growing tree plantations, the benefits — both from employment and from wood products — are evident. Since about one third of the biomass is available for fuel this vastly exceeds the gleanings from wasteland. Sadly, the pressure of rapidly increasing population and the polemic nature of the political arguments tend to inhibit rational debate on the land-use issues.

Nine papers on growth patterns, plantation techniques and nutrient cycling include one of particular interest from the Institute of Terrestrial Ecology in the UK. Harrison, Dighton and Jones describe a new method of bio-assay of the nutrient status of plantation trees at various stages of development. Excised live roots are placed in solutions containing a mixture of radio-isotopes of the major nutrient elements. The uptake of nutrients in a standard time is claimed to be 1000 times more sensitive than the conventional chemical analysis of tissues. The results agree well with the known histories of fertilizer applications when tested in plantation experiments. The method could be of service in other tree plantations of commodity crops.

The remaining 15 papers are devoted to water-use studies in India, Australia and South Africa. The first is by Dr Calder, who led the team from the Institute of Hydrology and the Oxford Forestry Institute: they took part in the experiments during periodic visits to Karnataka.

Other papers describe the methods, results and modelling of transpiration by deuterium tracing, of soil moisture by neutron probes, of interception losses and of transpiration by stomatal conductance and leaf area index. A contribution from South Africa describes heat-pulse measurements of transpiration in *Eucalyptus* plantations.

A comparison of water use by somewhat degraded mature forest with *Eucalyptus* plantations at two sites showed that both used all of the season's rainfall. At another site the *Eucalyptus* appeared to have used more water than the rainfall of a dry year, either from stored soil moisture or by increasing root depth. Modification of local climate by large areas of plantation was measured as the cooling and humidifying of the lower atmosphere.

A brief summary of the final discussion emphasised that rooting depth is a critical factor needing study and that the experiments should continue to a wider range of seasons.

The volume has a useful index. It will be widely quoted in future work on these very practical problems.

H. Charles Pereira

Northumbrian hydrology

Land of Singing Waters: Rivers and Great Floods of Northumbria, David Archer, Spredden Press, ISBN 1 871739 27 6 (hardback) £17.95, ISBN 1 871739 28 4 (paperback) £13.95. 217 pp.

This book has, effectively, two titles, no doubt to appeal to what will be a distinctly bimodal market. In "*Land of Singing Waters*" is a thoroughly rewarding read for those interested in the topography, history and natural history of Northumbria. In a region which orientates to its rivers (*viz* Tyne-Tees, Tyne and Wear, Newcastle upon Tyne) and which has many exiles whose nostalgia focuses powerfully on such images as "The Fog on the Tyne" this readership will be large and appreciative. The author has a flair and style of writing which appeals: he seeks out what journalists call the "human interest" aspect of each flood.

To those who purchase "*Rivers and Great Floods of Northumbria*", as might many a member of BHS, there is a fascinating but understated review of flood frequency (in the informal sense), flood factors (including hydroclimatology and land use) and the policy response to floods. In the latter category the author is tongue-in-cheek at times because he has played a major role in such matters as Principal Hydrologist with the NRA in the region. To a reviewer who spent an apprenticeship on the Floods Team at the Institute of Hydrology looking at floods as "regression fodder", it is a valid piece of hydrological analysis to put regional flood problems into both an historic and a local, catchment perspective. The Northumbrian River Authority always told us that its floods were "different" and that we would need to understand each catchment. With the eye of faith one might say that this is what the NRA itself has now learned to do at the highest policy level, although "Standards of Service" doesn't have quite the ring of "Singing Waters"!

To review this book in justifiable detail would be to copy it to this page. It is divided into catchments and catchment groups: Tees, Skerne, Leven, Wear, Tyne and then the smaller rivers of Northumberland. Two specialist categories are regional in scale and are, to this reviewer, the best research material: "Flash Flood" (the region experiences flood waves and peat slides) and "A History of Failure" (Archer has located eleven dam failures in the region — a very significant contribution).

Highlights of the text include "Britain's First Flood Warning Service" (the Rector of Hurworth riding down the Tees valley faster than the flood in the meandering river!), the story of Darlington's encroachment on to the Skerne floodplain — a lesson for all urban communities who want a river to be proud of — and the best compilation of detail about the 1771 flood in Newcastle. This was an event demanding the adjective "awesome": whilst the current Tyne Bridge is justly famous, had that of 1250 survived the 1771 flood Newcastle would now have had its own Ponte Vecchio and could justly claim to be "the Florence of the North"!

In the era of hydrometry the Tyne has recorded the highest flows in England and Wales and is only surpassed by the Rivers Findhorn and Spey in Scotland. Archer has made a careful quantitative survey of the many monumented flood marks recording the level of the 1771 and other historical floods in all the main catchments. He has also unearthed all the main documentary records of flooding and flood effects: the photographic material is superb. These data have already furthered the research programme of the University of Newcastle and now that they are put before a wider audience they can reach their full potential value.

In this and other ways the main scientific and technical contributions of the book lie beyond its pages, in which the author has justly given vent to his enthusiasm and experience. Both modes of readership therefore get a good read and, on reflection, a more profound philosophy regarding the problems of environmental change and its management. One hopes that both local councillors and NRA managers of Standards of Service note (on page 26) that during the 1809 flood on the Tees, "At Stockton race-course....horses ran belly-deep in water" — something there about flood hazard perception?!

Malcolm Newson
Newcastle University

Committee on hydrological science

Opportunities in Hydrology, National Academy Press, Washington DC, 1991

First, an apology for the tardy appearance of this review. This is in part because I have been unsure of my feelings about the appearance of this volume, which has been produced by the Committee on Opportunities in the Hydrologic Sciences (under the chairmanship of Pete Eagleson) of the Water Science and Technology Board of the Commission on Geosciences, Environment and Resources of the US National Research Council. It is a fairly common impression amongst hydrologists that,

even though their science is one of the most important of environmental sciences, with very important practical and technological implications, they have not been as "successful" as some other disciplines, where success is here defined in terms of specific funding programs for hydrological research.

There is a feeling that the hydrological community has not been sufficiently coherent in defining its research objectives and in obtaining support to achieve them, where meteorologists, oceanographers and even hydraulicians have been. This is, perhaps, in part, because hydrologists are a motley crew, drawn to the study of water from a variety of disciplines: geology, engineering, geography, meteorology, ecology, environmental science. There are still no undergraduate degree courses in hydrology in this country, although some of those in environmental science come close to an appropriate "interdisciplinary" programme. Others, such as Vit Klemes, have argued that progress in hydrological science has been limited because practical applications of hydrological knowledge have led to the development of methods allowing engineering designs and judgements to be made without firm scientific understanding. These types of consideration led to the formation of the NRC Committee on Hydrologic Sciences to try to define the objectives to be addressed in the 1990s and beyond.

However, this book does more than that and the Committee have done an excellent job in defining the scope, background and history of the subject. This is done in part through short, separate sections of about one page, scattered through the text at appropriate points, giving short summaries of critical problems, important hydrological events or potted biographies of eminent (dead) hydrologists. There is a lot of interesting and useful background material in these sections. The body of the text gives a brief history of hydrological science (chapters 1 and 2), identifies some critical and emerging areas (chapter 3), addresses scientific issues of data collection, distribution and analysis (chapter 4), education in the hydrologic sciences (chapter 5), summarises the scientific priorities (chapter 6) and then ends with a discussion of resources and strategies (chapter 7). Some summary tables of funding for hydrological research, and results from a questionnaire on the backgrounds of American Geophysical Union scientists affiliated to the Hydrology Section, are given as appendices.

The emphasis is on hydrological science rather than practice, and the five broad priority (but unranked) areas that this committee has identified are Chemical and Biological Components of the Hydrological Cycle, Scaling of Dynamic Behaviour, Land Surface-Atmosphere Interactions, Coordinated Global-scale Observations of Water Reservoirs and the Fluxes of Water and Energy, and Hydrological Effects of Human Activity. The background to these priority areas is expanded in the chapter on critical and emerging areas: the major part of the book. Clearly some of these areas are already being addressed, for example, in the interdisciplinary programs of GEWEX and IBGP, the ISLSCP and HAPEX experiments and the UK's own TIGER Programme. While it is possible to argue about the emphasis given to different problems of understanding hydrological science, there would, I think, be general agreement that most of the dominant problems of hydrology get a mention, even if in some cases (e.g. the scientifically fascinating and particularly important problem of preferential flow in soils) it is only a passing mention (but I am biased in this case!).

So why do I feel uneasy about the results of the deliberations of this Committee, whose eminent (living) participants clearly invested a considerable amount of their time? I must applaud their efforts to raise the profile of hydrology and their attempts to get hydrology recognised as a science in its own right by the funding agencies and in the education of the next generation of hydrologists. The nagging doubts, I know, come in part from a personal scepticism of the results of deliberation by Committee and the compromises that such deliberations inherently involve, but now believe that I recognise the fundamental problem with this study: the Committee have not recognised in this report (with good reason since it undermines their objectives) that hydrologists have no way of answering the scientific questions that they pose. Indeed, they have no foreseeable way of answering the questions that they pose. It is not a matter of development of theory. The pathways of water from rainfall to streamflow and evapotranspiration are currently unknowable, because we do not have the measurement techniques to evaluate those pathways at the scales of interest. Thus most of the critical and emerging areas that depend upon those pathways cannot be solved except in speculative and *ad hoc* ways.

The committee on Opportunities in the Hydrologic Sciences have "talked up" their science; I could now be accused of "talking it down". Since we all know that such "talking down" is the main reason for the recent poor performance of the British economy, I may be doing hydrological science an equal disservice. I would hope not for two reasons. The first is that impossible problems are themselves inherently interesting and can be used to spark the interest of the brightest minds. The second is that of avoiding self-delusion. The report of the Committee could be considered to be an exercise in normal science, within the current paradigm. This is not a criticism: it is difficult to see how the Committee, within its stated aims, could do anything else. The difficulties faced in hydrological science are predominantly those of observability, particularly of subsurface flow domains, and complexity, with its consequences for the ability to identify model structures and parameter values. What is needed in hydrology is a radically new set of approaches and ideas to deal with these inherent problems. It is difficult to see how they will come from work within the current paradigm and it may be necessary to look for stimulus outside the body of hydrologists: perhaps in new measurement techniques; perhaps in ideas from the emerging science of complexity.

A similar initiative is now being taken within the UK in the form of the British Hydrological Society Research Strategy forum, an initiative being undertaken in the context of the forthcoming Government White Paper on UK Science and Technology (*see p. 11*). It will be necessary to "talk up" the science of hydrology. I would certainly commend this book to the Committee as a good starting point for their deliberations. I just wish I could see where the new ideas will come from!

Keith Beven
Lancaster

Hydrological tables

Hydrological Tables, Tom Beer, Applied Environmetrics (Melbourne), 1991, 73pp + computer diskette. ISBN 0 9590809 3 7. £75 UK Distributor: Catchment Area Technologies, Whitehouse Lodge, Brightwell Baldwin, Watlington, Oxon OX9 5NT.

I have in the past bought books with diskettes included, on computer languages and fractals for example, but this is the first hydrology text I have seen with one inside the front cover. Indeed, perhaps referring to it as "text" book and calling this a "book review" is a misnomer. In this case it would be, in fact, a bit like reviewing software and writing only of the user documentation.

The author, who was aided by an international panel, works as a consultant dealing with pollution and forest fires and the book springs out of his need to have ready access to information needed to make calculations relevant to his work. The approach adopted is to give a brief description of formulae relating to hydrological and meteorological phenomena but the answers are not presented as tables or graphs but are obtained from a program on the diskette called TABLES.

To start with I tried doing things that the documentation said the program could do. Like setting the program

up, running it and calculating the vapour pressure. All of this worked as described. The use of function keys in general follows standard practice, for example <*F1*> gives you on line help and <*Esc*> takes you back a step. The on-line help gave a lot of useful additional background information which did not just repeat the user guide. Some of the keys do not seem intuitive, but then, as anyone who has spent the morning editing programs with a text editor and the afternoon with a spread sheet would tell you, 'intuitive' is not easily defined.

At a programming level TABLES works well and I did not manage to make the program crash and the use of the keys seemed to be internally consistent. For example, I have used software where sometimes typing a response on its own was enough and at other times you had to follow the response with the <*Enter*> key. In this program I never encountered that problem. I also, by mistake, produced some very large numbers and the program just put the word "overflow" where the number would have been. Two nice touches are the exit to DOS, where the program runs a short batch file which gives you a number of likely options rather than just dumping you into DOS, and the table print out, which does a screen dump that you can control by marking which part of the screen you want printed. The exit to DOS can be further extended by the possibility of user defined batch files to be executed.

Whilst it is all very well doing the examples in the user guide, what you want to know is "Can the program do what I want it to do?". So I decided that what I wanted the program to do was to print out a table of values of vapour pressure for a range of temperatures and also to print a Chi-squared table. After looking more closely at the documentation I discovered that it did not allow for Chi-squared so I opted for Pearson III distribution instead.

Trying to get a table of vapour pressure values introduced me to the HYDRO.SET file. The program itself is easy to use, if what it does is exactly what you want. But you can get it to do other things by modifying parameters in a file called HYDRO.SET. So, for example, you can define starting values and increments for tables to be printed. The description of how to do this I found hard to follow (which is a polite way of saying that I refuse to admit I lack the intelligence to understand it but I could not get it to work properly). As this file is essential for the program to run, the author has thoughtfully provided a second copy with a different name. It might have been better to go a stage further and make this copy a 'read only' file to avoid accidental erasure. I never did manage to get my table of vapour pressures. On the other hand I did succeed with the table of Pearson III coefficients and, what is more, when I compared them with those in *Applied Hydrology* (Ven Te Chow *et al.*) they were the same. (Well not exactly the same - as the two sets of values are presented in different ways - but they were numerically equivalent.)

Having got this far, what are my impressions of the program? Firstly it does what it sets out do well and with a minimum of bother. The keys are easy to learn and the program itself seems to be stable and robust. But, as you might have gathered from the above, I am not sure that I would rush out and buy a copy. The reason for this is that the information the program gives is only part of the process from 'raw data' to a 'decision'. For example, getting the Pearson coefficients for different return periods, is only part of analysing a flow record, checking the data for accuracy, deciding what return period is sensible for a design, selecting an appropriate distribution and arriving at the corresponding flood. Another example would be the calculation of PET by the Penman formula. What you generally need is to take series of data over a period of time and to calculate the appropriate potential evapotranspiration figures.

The program has the makings of a useful tool but until it can be better integrated with other tasks it will not fulfil its full potential. For example, rather than having to edit the HYDRO.SET file, the possibility of changing a range of variables to be tabulated within the program should be easier. The inclusion of only Pearson III (though in logarithmic and natural forms) is too limiting: other distributions could usefully be included as well as Chi-squared tests, for example, to decide which distribution is most appropriate. It would also be useful if the program could accept, say, a series of annual maxima as data, and calculate the mean and other moments for use with the distribution.

This is the first version of the hydrological tables program. It is better than most version 1.0 programs, but I know from experience of other software packages that it is only when users have had a chance to comment that programs become stable and flexible software tools. I look forward to future versions of the hydrological tables.

Ron Manley

A Book to Displace Freeze and Cherry?

Physical and chemical hydrogeology, P.A. Domenico and F.W. Schwartz, 1990, John Wiley. 824 pages, including excellent index. Around £20, Paperback.

This is an excellent textbook on groundwater and must have already displaced *Freeze and Cherry* as the standard text on the subject. This is not just because it is a third of the price, but also because it is a modern and up-to-date review of groundwater, carefully presented in a well-structured and easy-to-understand form. (This is not to imply that *Freeze and Cherry* is not an excellent textbook, but it is 14 years old and the subject is fast moving).

Even the best of books have their shortcomings and I deal with a few of these now. Even 824 pages is not enough to get up to MSc level in all aspects of hydrogeology, which shows how much research and application has been developed in the past couple of decades. For example, the sections dealing with the unsaturated zone, recharge and groundwater resources are relatively thin. This seems to reflect the North American attitude that groundwater resources, and the associated recharge estimates, are either trivial issues, simple to carry out, or only depend on analysis of groundwater flow. This of course completely contradicts the UK view, whether dealing with the hydrogeology of the Chalk, Triassic Sandstone and drift cover, or dealing with resources in arid and semi-arid climates as so many of our practitioners do.

Domenico and Schwartz are both mathematically inclined and have applied their skills to a wide range of groundwater problems. This research background is reflected in the contents of the book, but the maths is only used when necessary and is straightforwardly presented — it should not intimidate even a hydrogeology student. They are able to present the role of groundwater in regional basin hydrology, the Earth's crust, heat transport (including geothermal energy and nuclear repositories), solute and mass transport, as well as the role of groundwater in carbonate rocks and mineralisation and the migration and entrapment of hydrocarbons. The book flows smoothly forward into more conventional hydrogeology topics, including good introductions to contaminant problems, organic and inorganic chemistry, modelling of contaminants and remediation of contaminated groundwater.

Overall I can strongly recommend this book.

David Lerner
University of Birmingham

Reference: Freeze, R.A. & Cherry, J.A., 1979. *Groundwater*, Prentice-Hall, Englewood Cliffs NJ, USA.

Copy Deadline for Issue No. 39 9th July 1993

Institute's Silver Jubilee



The Director, Professor Brian Wilkinson, unveiled an IH Automatic Weather Station to commemorate the 25th anniversary of the Institute of Hydrology in April 1993.

Making more use of Circulation

Have you noticed that recent issues of *Circulation* have been carrying more job adverts? This is because it is obviously a good way to bring such information to the UK professioal hydrological community. If you have similar sorts of 'ads' about vacancies, consultancies, research grants, awards, services, etc., which you think fellow members would appreciate having brought to their attention, do let us know. This seems to me to be an important service that a newsletter should offer its readers.

Editor

Promoting the BHS

Perhaps not surprisingly, we have been 'underwhelmed' with ideas for a BHS tie (you were all too busy worrying about the practical implications of yet another dry spring, weren't you?). Nevertheless, we are exploring the costs of ties, scarves and possibly T-shirts or sweatshirts tastefully displaying the BHS logo: more news in due course.

Editor

Appeal for publications

Professor Ognjen Bonacci has written from Split University in Croatia, appealing for donations of recent books and papers in the field of hydrology and water resources, particularly those related to rainfall and climate change.

He writes: "As we are actually at war, the economic situation is difficult. Neither the Faculty nor we ourselves are in a position to obtain professional books and papers. Scientific research cannot be continued without recent publications."

If members are able to help, Prof Bonacci's address is: Civil Engineering Faculty, Split University, Split Matice Hrvatske st. 15, Croatia.

New IH Report

The Institute of Hydrology has just published *Report No. 121*, "Peaks-over-threshold flood database: Summary statistics and seasonality".

The seasonality of flooding in the UK is described by circular statistics and extensive appendices present summary and seasonality variables for 857 gauging stations. Maximum, median and mean values are listed for nearly 1000 annual maximum series.

It may be ordered from the Librarian, Institute of Hydrology, Wallingford, OX10 8BB, price £15.

FORTHCOMING EVENTS

Meetings

International Symposium on ENGINEERING HYDROLOGY
San Francisco
27-30 July 1993

Held in conjunction with the ASCE Hydraulic Engineering Conference (starting on **26 July**), the full details are not yet available. Members who are interested should contact **Frank Law** at the Institute of Hydrology (Tel. 0491 838800, Fax 0491 838097).

International Workshop on GLACIER HYDROLOGY
Cambridge
8-10 September 1993

Held in parallel with the Fifth International Symposium on Antarctic Glaciology (starting on **5 September**), this workshop will provide a forum for discussion of developments in glacier hydrology. Members who are interested should contact **Dr David Collins**, Dept of Geography, University of Manchester, Manchester, M13 9PL (Tel. 061 275 3646, Fax 061 273 4407).

19th WEDC Conference
WATER, SANITATION, ENVIRONMENT & DEVELOPMENT
Accra, Ghana
6-10 September 1993

Focussing on water supply and treatment and disposal of waste, this conference includes 40 parallel sessions, technical visits and, above all, discussion.

Details from **Prof. John Pickford**, WEDC, Loughborough University, Leicestershire LE11 3TU (Tel. 0509 222390, Fax 0509 211079).

NATO Advanced Research Workshop
ECOSYSTEM MODELLING
Bischofsgrün, Germany
20-25 February 1994

This workshop, which is limited to 30 participants, will explore the limits of the current reductionist approach in assessing ecosystem response to envir-

onmental changes. Themes are the ecosystem as a scientific unit of study, critical evaluation of ecosystem models and theoretical limits to physical or biological resolution in these models.

Papers are requested on these themes: e.g. modelling forest ecosystems, hydrological models at the catchment scale, case studies of the limitations of modelling. Further suggestions about organising the work-shop will be considered up to **15 June 1993.**

Applicants should submit a statement of research interests and relevant publications by **15 October 1993.** They should give a tentative title of any paper they wish to submit, outline computing facilities they would need for demonstration of a model and state whether they are a "splitter" or a "lumper".

The venue is in the Fichtelgebirge, near Bayreuth in Lower Bavaria. Applications should be sent to **Michael Hauhs**, BITÖK (NATO-ARW), Universität Bayreuth, Postfach 10 12 51, D-8580 Bayreuth, Germany (Tel. +49 921 7857 151, Fax +49 921 7857 299, Email ARW@bitoek.uni-bayreuth.de)

International conference
WATER ENVIRONMENT 1994
London
9-10 March 1994

IWEM and the ICE have combined forces in this conference, comprising two one-day seminars with a common theme, summarised as "Wastewater treatment: what's it worth?"

The first day is devoted to strategic considerations (for policy makers) and the second concentrates on specific details in case studies, but many practitioners are expected to attend both.

A 300 word synopsis of each paper submitted should be sent in by **1 June 1993.** An exhibition will run in parallel.

Details are available from Carol Chin at Thomas Telford Services Ltd, 1 Great George Street, London SW1P 3AA (Tel: 071 839 9803, Fax: 071 233 1743).

Courses

Two-Day Workshop on
WATER QUALITY MODELLING
Imperial College, London
21-22 June 1993

This workshop is intended to introduce to environmental scientists, engineers and managers the public domain water quality modelling software available in the USA. Participants will be introduced to the QUAL2E model and will be given the QUAL2E-UNCAS software and documentation. These models are important tools for managing water quality and should be of benefit to environmental decision-makers.

The non-residential fee is £375. For further details, contact Pamela Manser, Continuing Education Centre, Imperial College, Room 558 Sherfield Building, London SW7 2AZ, *Tel: 071 225 8666/7.*

Seminar on
DETENTION STORAGE IN URBAN DRAINAGE
Harrogate
10 June 1993

Detention storage is commonly used to reduce the impact of urban drainage on river systems, in terms of flood and influx of pollutants.

This seminar introduces new techniques for design, modelling and use of detention storage and should be of use to planning engineers from the dischargers and the regulating bodies.

Details are available from Jacqueline Watts, HR Wallingford, Howbery Park, Wallingford, Oxon, OX10 8BA. Tel. 0491 835381, Fax 0491 826703.

Diary

9th June 1993
BHS Midlands Section Meeting
"Water grids"
Venue: Severn Trent Water, Sheldon
Time: 11.00 a.m.
Contact: Paul Webster, Dept of Civil Engineering, University of Birmingham, Birmingham, B15 2TT. *(Tel: 021 414 5055, Fax: 021 414 3675)*

21st-22nd June 1993
2-day Workshop
"Water quality modelling" – Professor Linfield Brown, Tufts University, USA
Venue: Imperial College, London
Contact: Dr Mervyn Jones, Imperial College, London, SW7 2AZ. *(Tel. 071 225 8666; Fax: 071 225 8668)*

21st-25th June 1993
HRL/Techware conference
"Flood mitigation and control"
Venue: University of Bristol
Contact: Dr Roger Moses, University of Bristol. *(Tel. 0272 303030 ext. 3060; Fax: 0272 251154)*

23rd June 1993
BHS National Meeting
"Rainfall-runoff models"
Venue: Imperial College, London
Time: 10.00 a.m.
Contact: Dr Howard Wheater, Dept of Civil Engineering, Imperial College, London, SW7 2BU. *(Tel. 071 589 5111 ext. 4736; Fax: 071 823 8525)*

13th July 1993
BHS National Meeting
"Hydrogeology of wetlands"
Venue: University of Birmingham
Contact: Dr David Lerner, School of Earth Sciences, University of Birmingham, Birmingham, B15 2TT. *(Tel.: 021 414 6156, Fax: 021 414 3971)*

13th-16th September 1993
4th BHS National Symposium
Venue: Cardiff University
Contact: Rob Drayton *(Tel. 0222 704321)*

14th September 1993
Welsh Hydrological Group
AGM: "Regional water transfer schemes"
Venue: Cardiff
Time: 6.30 p.m.
Contact: Linda Aucott, NRA Wessex Region, Bridgwater *(Tel.: 0278 457333, Fax: 0278 662153)*

13th-15th October 1993
2nd International FRIEND Conference (Flow Regimes from International Experimental and Network Data)
Venue: Braunschweig, Germany
Contact: Prof. Dr A. Herrmann *(Tel: +49 531 391 5607, Fax: +49 531 391 4577)*

13th-15th October 1993
IDNDR Conference
"Protecting vulnerable communities"
Venue: The Royal Society, London
Contact: Rachel Coninx, ICE Conference Office, 1-7 Great George Street, London SW1P 3AA *(Tel: 071 839 9807, Fax: 071 233 1743)*

15th October 1993
Welsh Hydrological Group
"Effect of mine closure on water quality"
Venue: University College, Swansea
Contact: Linda Aucott *(address above)*

17th November 1993
ICE/BHS/IAHR/NRA Seminar
"Sustainable water resources"
Venue: Institution of Civil Engineers
Contact: ICE Conference Office, 1-7 Great George Street, London SW1P 3AA *(Tel: 071 839 9807, Fax: 071 233 1743)*

Circulation is the quarterly newsletter of the British Hydrological Society. It is issued free to members, but is also available on an annual subscription of £19. All enquiries concerning membership should be made to Louise Picton, Institution of Civil Engineers, 1-7 Great George Street, London SW1P 3AA. Telephone 071 839 9836. Please address all other correspondence to the Editor, Celia Kirby, Institute of Hydrology, Wallingford, OX10 8BB. Telephone: 0491 838800 extension 2360. Fax: 0491 832256.

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