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Cardiff Symposium: a great success!

4th National Hydrology Symposium - Cardiff

The best one yet?

Certainly this was a most enjoyable meeting, judging by the unsolicited compliments that were rightly showered upon the heads of the local organisers, Rob Drayton and the team from the School of Engineering at Cardiff's University College of Wales.

UNESCO's Head of Water Sciences, **Andreas Szollosi-Nagy**, who stepped in at the last moment as our invited guest* gave an outstanding keynote address. His talk *Water science issues at the dawn of the 21st century: challenges for IHP and BHS* had many profound messages, punched home with some wonderfully apposite slides, and set us off an a high note which carried on throughout the whole meeting.

The 38 papers presented during the meeting made interesting technical sessions and sparked off several lengthy discussions. The prize for the best paper went to **Steve Rose** of the ADAS Soil and Water Research Centre for his paper (with co-authors **Graham Harris**, **John Williams** and **David Mason**) on "Impacts of agricultural activity on water quality", but only after prolonged debate by the impromptu Papers Committee who had just 10 minutes at the end of the proceedings to make their final decision. Indeed, **Nicole Archer** ran Steve a close second and was very highly commended.

The medieval banquet at Cardiff Castle was a particularly pleasant occasion. Future symposium organisers should note that we have a strong core of musical - indeed lyrical - members [mostly Celtic in origin, I think - Ed] who obviously like nothing better than the chance to show the rest of us how uncultured we are and ignorant of Britain's vast heritage of traditional airs.

And the Conference Dinner? The food was great, the speeches (by **John**



Posse of past and present Presidents posed to provide pretty picture for periodical

*__Prof O Storosolszky__ of VITUKI, Hungary, was unable to attend because his wife was taken ill.

Rodda and **Ron Edwards**) nicely in tune with the mood of their audience, all leading us on to the highlight of the evening, the Hydrological Games, described below by past President **Mike Lowing**:

Royal corgi richly lyrical? Hardly!

The games at Cardiff ended on a high note for the 'Drag and Drop' team as we came from fifth position to joint first place and downed our champagne prize.

With the Director General of WMO's Hydrology and Water Resources Department on board we had high hopes of scoring well in 'Hydrological facts and figures', but it was not to be. All familiarity with units, conversion factors and the world's rivers seemed to have been mislaid at an earlier point in the evening! However, the final question was our salvation: how many words, of five letters or more, can be composed from the letters of 'HYDROLOGICAL'?

We were not allowed the obvious 'logic' and 'logical', which was a disappointment because that was all we could see at first. However, a rare flash of insight enabled us to appreciate that the letters could be placed in *any* sequence, and then we were away. Our score of 26 was enough to achieve a share of the prize, but subsequent contemplation and some (*Concise Oxford*) dictionary scouring [The Past President now having nothing better to do with his time presumably — Ed] has produced the following 117:

Acidly	Dilly	Holiday
Acrid	Doily	Hollo
Alcohol	Dollar	Hooch
Alloy	Drill	Hooray
Archly	Drily	Hyaloid
Argil	Droll	Hydra
Argol	Drolly	Hydric
Cargo	Drool	Hylic
Carol	Gaily	Hyoid
Chair	Gallic	Ichor
Chard	Garlic	Idyll
Chary	Ghyll	Igloo
Charily	Girly	Laird
Child	Glair	Larch
Chill	Glory	Lardy
Chilly	Glycol	Lilac
Chloral	Gloria	Lordly
Choral	Gladly	Loach
Choir	Gorily	Local
Chord	Godly	Lochia
Choroid	Goodly	Loral
Choric	Golly	Lorcha
Cigar	Goody	Loyal
Clary	Goral	Lyric
Coldly	Gorilla	Lyrical
Collar	Grail	Oligarch
Colloid	Grill	Oligarchy
Cooly	Hairy	Orally
Coral	Hallo	Orchil
Coralloid	Halloo	Orchilla
Cordial	Haloid	Racily
Cordially	Hardy	Royal
Corgi	Hardly	Riyal
Daily	Hidalgo	Roach
Dairy	Hilly	Rally
Diary	Holly	Richly
Dally	Hoard	Radio
Diarchy	Hoary	Radiology
Dolly	Holily	Yahoo

— Any more?

Cardiff Symposium: Report on the discussion

This report has been compiled by Jim Blackie from notes made by reporters Paul Jowitt, Richard Harpin, Jim Blackie, Mike Knowles, Stewart Child and Terence O'Donnell.

Session 1 Water Resources

After the subliminal heights of Dr Andreas Szollosi-Nagy's illustrated address, the Symposium got down to business with a series of papers on Water Resources.

The session opened with **Terry Marsh**'s presentation on the UK's vulnerability to drought, illustrated by particular reference to the period 1988-1992 and with comparisons to previous drought experiences back to 1780, including a report from the "Thunderer" of the 1868 Drought. This wide-ranging presentation provided a thought-provoking start to this 15-paper Session. Asked by **Prof Brian Wilkinson** if Europe-wide drought analysis was a prospect, Terry indicated that something along those lines might appear within the next decade.

In the second paper, presented by **Robert Wilby**, a synoptic-hydrological model was used to assess the relative significance of climate, land use and groundwater abstractions on river flow characteristics. The paper contained two case studies: the Upper Thames and two Norfolk rivers, the Wissey and the Babingley. In the latter study, the Q50 and Q10 flows seemed most sensitive to land use. Brian Wilkinson wondered how the synoptic model compared to a traditional model, especially at low flows. In fact, Terry replied, the synoptic model had been calibrated against low flows.

Chris Holt and **Jeremy Jones'** paper, on the potential impact of global warming on water resources management in upland Wales, used scenarios derived from General Circulation Models as inputs to standard models and procedures used by Welsh Water.

The results suggest significant reductions in resources, particularly in summer. Asked how these climate change scenarios might themselves affect demand patterns, Chris Holt replied that this aspect of the problem was not part of their study but was being tackled elsewhere.

Global warming having been introduced, the session warmed up further with **Tim Wyatt's** presentation of a paper on drought management measures and water resource system operating policies (co-authors **John Ringham and Hilary Smithers**). The timescale of the optimisation and simulation models presented was consistent with the changes in demand resulting from demand management arising from DOE-approved drought orders, although the incorporation of drought orders themselves was confined to the simulation component rather than the optimisation phase. The work provided a clear picture of the feasibility of applying this modelling approach to the optimisation of operating policies for complex water resource systems.

Nigel Hepworth sought clarification on the validation procedures, the hydrological input and yield assessment techniques incorporated in the approach. Tim Wyatt replied that these aspects had been part of the earlier MOSPA development: it was indeed a complex issue necessitating simulation down to a daily frequency.

The next paper was from **Anthony Tollow**, once of Anglian WA but now representing the South African Chapter of BHS. He described the potential for the use of a constrained optimisation model, incorporating recycling and effluent disposal, to assist with demand management, particularly for industrial usage. In reply to **John Gardiner**, he indicated that the approach could be applied to surface water management, for example in water use by fish farms. Prof Brian Wilkinson wondered if the approach had been applied in practice, but it was in fact still being developed.

The final paper in the morning, by **Rachel Marriott** and **David Archer**, was on the subject of Kielder Water - White Elephant or White Knight? Whilst acknowledging that the demand forecasts which led to its construction have proved to be unrealistic, the benefits obtained in recent drought years — through transfers to the Tees, Wear and Derwent in particular — were emphasised, as well as the possibility of

extending transfers to meet growing demand in Yorkshire and further South.

In the discussion **Frank Law** affirmed that he was of the "White Knight" tendency: Kielder had saved the Derwent and had been a factor in the location of the Nissan car factory in the area. **Susan Walker** expressed concern that greater stress on the aquatic environment might result from a tendency to allow greater drawdown of local sources, knowing that Kielder would provide support in the longer term. Rachel Marriott acknowledged this but guidelines were now being issued to conserve compensation requirements. **Logan Jack** pondered on the effect of positive "K" values and the effects of the recession. Why hadn't the forecast growth in metered demand slowed down rather than remaining constant as implied in the paper? White Knight David Archer replied that some companies were showing a falling growth demand but were reluctant to forecast a continuing future fall. **David Evans** commented that Kielder had provided some unexpected payoffs and security against unexpected circumstances. Brian Wilkinson asked if there were prospects for transfers further afield, for example to the Swale. Yes, replied Rachel, but the emphasis was still on local sustainability.

In the plenary discussion the view was expressed that the water industry might be in for some stick with many rivers going below what were regarded as their environmental limits. Nevertheless, there was a need for more flexibility in setting rule curves. Tim Wyatt expressed the view that Ofwat should be pressed on supply restriction definitions to cover both frequency and duration. **Neil Whiter** indicated that "DG4" reporting did now require information on durations. As lunchtime approached, **John Rodda** of the BHS WMO Chapter returned to Terry Marsh's paper: when would the next drought be? Terry said that such a prediction exercise would be fun but unscientific. He confined himself to commenting that, in the minds of the popular press, the last drought ended on 22nd September 1992, when between 60 and 90mm of rain fell on lowland England.

Anthony Tollow reported that an unnamed Professor of Hydrology had predicted the end of the South African drought within days. Unfortunately, if he is wrong it will not be quite so much fun!

Allan Lambert started off the afternoon part of the session with his paper on Leakage Control: A Perspective for Hydrologists. In his "Tale of the Elephant and the Five Blind Men" he gave a personal overview of some of the key issues in leakage control for the non-specialist. He compared estimation of leakage with estimating evapotranspiration losses from catchments.

In response to a question from **Linda Aucott**, Allan Lambert said that the policy was to keep pressures as high as possible. **Ron Manley** asked whether the volume of water in pipes had been considered as a replacement for the parameters L (length of mains) and N (number of properties supplied) when considering distribution losses. He was told that they had not considered volume, but they had considered the length of Communication Pipes (from mains to property boundary). The main influencing factor is the duration of bursts. However, once conceptual models are in use it was thought we would be able to express losses in Mld^{-1}.

John Adams then presented his paper with **Wally Ball**, Microcomputer Systems in Hydrometry — Implementation Experiences. This described the development of the NRA North West Region's Hydrometric Information Service, facilitated by improvements in microcomputer systems. There were definite benefits from adopting a user-oriented development process for this type of information system. The process produced a committed development team. One benefit of the new microcomputer-based system over the old mainframe was the ability to generate graphs on screen, facilitating data checking. Data validation is best done by those who collect it in the field.

In reply to **Terry Marsh** Dr Adams said that training was important to ensure that staff cope with stage-discharge relationships. **Peter Thompson** asked how well the distributed system was working and how validation was checked to ensure consistency of the approach, given the distributed data processing. On an area basis, moving data around did require good management and there were two working groups looking into this. Data validation was in a process of change and they were looking at the way data is validated and moving more towards validation in the field. Data transfer was much more secure.

Roger Goodhew asked whether water quality colleagues would follow the example (presumably a rhetorical question). Dr Adams told **Nigel Fawthrop** that the network of TG1150s were used predominantly for hydrometry, but also for water quality and flood warning purposes. Nigel also asked about the pros and cons of the PC-based system against more ambitious schemes such as WIS and a possible National IT Strategy. Dr Adams would like to keep the current system as long as possible, to maintain continuity and stability. He also indicated, following a question from **Paul Hodge**, that the current NRA 'Market Testing' would help.

Andrew Pimperton and **Mike Karle** presented their paper on the variation of roughness coefficient with flow in natural river channels as a slick double act. They described an eight-year study by NRA Severn Trent to produce more reliable estimates of Manning's 'n' based on direct measurement at selected gauging sites covering about 500 hydrological events. It was concluded, following analysis of the data, that Cowan's approach, using six channel factors, gave the most objective assessment of roughness and gave more reliable estimates at bankfull than did the use of reference tables.

Richard Harpin asked how typical were the results of the whole river system and how valid was the conclusion about Cowan's method, given that only gauging reaches were used, which were probably not typical. Andrew Pimperton said that the data set did include a meandering channel, and he thought that the general conclusions about Cowan's method should be acceptable for other reaches. **John Gardiner** was informed that the factor 'm' in Table 3 was multiplicative not additive as were the other parameters. **David Archer** referred to the downturn in the graph for Bewdley in Figure 2c which indicated out-of-bank flow. He was informed that this was a mistake, which he should not have included. In response to **Peter Towlson** on the difficulty of determining the slope in fieldwork, David explained that cross-sections were taken at regular intervals and further level gauges were used: the slopes should be reliable.

Richard Boak presented the paper, written with **Ken Rushton**, on assessing aquifer exploitation from observation wells and piezometers. Important information, which should be deduced from observation wells and piezometers, is often not identified because of an inadequate understanding of the flow mechanisms within the aquifer system. A frequent situation is the failure to identify correctly vertical flow through a low permeability layer overlying the aquifer, or vertical flow within the aquifer itself. Field examples included conditions in an overlying low permeability layer (Fradley), regional response of an aquifer (New Road, Bromsgrove) and response close to a pumping station (Trent Valley, Lichfield). Correct interpretation of data was important; data from open observation boreholes which penetrate several aquifer or aquitard layers can be misleading. Vertical flows can have a significant effect on the behaviour of pumped boreholes, and on the balance between abstraction and resources in an aquifer. If it is known that vertical flows are occurring, great care should be taken over analysis of pumping tests and interpretation of regional groundwater behaviour.

David Archer asked what were the water quality implications of vertical flow and was warned that it would no longer be safe to assume that a 'confining layer' is actually confining: there are implications that pollutants will eventually come through.

Chris Soulsby asked, given the complexities of flow through retarding layers, what is the implication for NRA policy of protecting groundwater. No response was offered: presumably the NRA will need to give this matter some consideration.

Alan Weston presented a joint paper on the NRA's research project on surface water yield assessment, co-authored by **Allan Lambert, John Mawdsley** and **Steve Mayall**, which described a procedure developed to assess the yield of complex, predominantly surface water resource systems. The procedure could be used by water companies when reporting yields to the NRA. The method, based on behavioural analysis using historic records, needs to incorporate realistic operational management procedures.

In her paper on the sensitivity of sources in North West England to different definitions of reservoir yield assessment, **Hilary Smithers** reviewed the application of the concept of reservoir yield in the light of moves to establish recommended national procedures. She illustrated the variety of yield definitions in use, and pointed to a general move away from static towards dynamic yields: this has the advantage that frequent operating adjustments can be made, thus reducing the effect of errors. Dr Smithers thought it unlikely that a prescriptive yield definition could be agreed to cover all types of UK resource systems in all circumstances, but discussion of the issue was extremely beneficial.

In a combined discussion on these two yield papers, **Ron Manley** noted that the word 'stochastic' had not been mentioned: was it dead? Dr Smithers thought that it would come back; Alan Weston said that the feeling was that we cannot do daily stochastic models.

Ken Howard wondered about Alan Weston's graph showing that changing the operating policy halved the yield: there could be hundreds of ways of operating the system. Alan replied that the graph was merely an illustration of extremes.

Mike Lowing asked, given lots of data, how many years should be included in the analysis. Allan Lambert thought that going back before 1920 did not make much difference, unless there was a particularly large reservoir involved: 70 years of data should be sufficient to define a 1 in 100 year level of service.

John Hall's paper, presented by **David Keiller**, described the findings of a study for Seven-Trent NRA to assess the resources of the River Trent, to identify existing and future demand, and to develop flow control rules to ensure equitable resource sharing. The draft control rules presented in the paper aimed to protect the interests of existing users whilst maintaining environmental quality standards. Current knowledge of flow requirements on the Trent for certain in-river uses is still far from complete.

John Gardiner said that it was good to see an example where effects on an estuary a long way upstream were being considered. He questioned whether the flow which could be taken was acceptable for the channel morphology upon which the ecology could be sustained.

Allan Lambert wondered if the NRA region would be legally liable to people elsewhere who were making use of water transferred to them from the Trent area.

This theme of water transfers was amplified by **Tim Askew** in his presentation of his paper with **Rob Brown** on bulk water transfer systems. He outlined three schemes for inter-regional water transfer, highlighted some engineering issues, gave examples of potential impact on donor and receiving river hydrology and discussed the environmental issues arising.

In response to **Tim Wyatt**'s question on the price of potential compensation to the donor, **Ken Howard** said that, although this was outside their remit, control rules did take into account existing abstractions. Tim Askew informed **Len Taylor** that they had indeed reviewed the CWPU study done some years previously on the same issue.

At this point **Ken Clarke** surrendered the Chair to **Bill Harris**, chairman of the Welsh Hydrological Group of the ICE, who explained that the final paper of the day also formed the prelude to their AGM.

The new chairman then called on **John Taylor** of the British Waterways Board to present his paper on regional water transfers using the inland waterways. In the paper he considered the future role of inland waterways for both regional and inter-regional transfers and summarised a feasibility study to transfer water from the north-west to the south-east. Mr Taylor also believed that the use of inland waterways as a source of raw water for industrial purposes could be enhanced and may provide an element of competition in the water supply market place.

Logan Jack asked what was the nature of the benefits to Waterways and Mr Taylor replied that they are taking a very wide view. They are not necessarily considering one end-user — there could be several. It was difficult to say which was the most beneficial option; there would be other benefits in terms of dredging, etc. **Mike Lowing** asked whether the transfers were to be base load or to boost supplies in drought conditions. Mr Taylor said that initially transfers were intended to act as a booster, but more recently it seemed that there may be a market for base load supplies. Mr Taylor agreed with **Peter Towlson**'s thoughts that 200 Mld^{-1} was probably a practical upper limit for the Seven to Trent transfer.

Session 2 Environmental Aspects

The eight papers presented in this session covered a broad range of topics relating to the interactions between hydrology and other environmental factors. The "flight" took off on time and stayed strictly on schedule in the capable and experienced hands of "Captain" Rodda.

As we climbed away **Chris Hughes** took us through the safety procedures by reminding us of the types of development for which environmental assessments are mandatory. The government proposes to extend the statutory requirements to cover other developments such as windfarms, water treatment works and golf courses. He illustrated the assessment of the hydrological effects of a development by describing the approach taken to a proposal to build a new sewage treatment works for Aberystwyth. He stressed the need to be aware of the statutory EA requirements, criticised their present inadequate scope and emphasised the need for close consultation with the statutory consultees and with experts from other disciplines when carrying out EA.

With seat-belts now unfastened, **Chris Soulsby** initiated the in-flight entertainment. His paper on episodic acidification in the uplands illustrated the points made with data from the Llyn Brianne study. After pointing out the unfortunate transposition of his Figures 4 and 6, he described the effects on stream pH and Al, Cl, SO_4 and NO_3 of snowmelt, high sea-salt content and summer storm events. The extreme values reached in these events have significant implications for the ecology of acid-stressed streams, whilst the relative values under different input conditions provide important information on the hydrological processes. He ended by stressing the importance of carrying out storm based monitoring on such streams.

Gareth Roberts queried whether the mass balances of the streams indicated a trend towards greater acidity, but Chris responded that long-term trends were not easy to determine from the data available.

Having achieved cruising altitude, **Hugh Goldsmith** made some of us think ahead to lunch with his frequent references to crayfish and trout in presenting the paper by him, **Vicky Morgan** and **Nick Oxley** on abstraction for public water supply and environmental demands on resources. This paper tackled the ongoing problem of defining acceptable minimum flows from the ecological viewpoint. Fourteen receptors were identified as possible indicators of environmentally acceptable low flows in a case study on the Worfe in Shropshire. The brown trout population was found to be the best indicator in this case. Using this "metric" it was found that present

abstractions resulted in periods of flows below acceptable limits. Indications of how the requirements could be met by reorganising the spatial and temporal distribution of abstraction were given. This low cost, simplistic approach is open to criticism but has a part to play until more complex habitat simulation models become readily available.

Well into the flight now, **Steve Rose** persuaded us to look out at the agricultural landscape and note with concern how little of it is now composed of wetland. In his paper with **Vicky Morgan** and **Joanna Treweek** he described the development and calibration of a model for assessing the likely problems in using existing drainage systems to rehydrate former wetland areas to meet specified ecological objectives. The model worked well: the results emphasised the need for careful assessments of soil characteristics and available water resources before undertaking this type of wetland re-establishment.

In response to a query from **Kevin Gilman**, Steve said that the soil parameters had been determined by field measurement in this case, but that optimisation of their values would be possible in some circumstances. **Derek Gamble** then asked about the effects of varying the ditch spacing. He was told that the hydraulic and economic consequences of this form part of the next phase of the study.

After coffee had been served, **Kevin Gilman** picked up the wetland theme with his paper on actual evaporation rates from a soligenous mire community as determined by a computer controlled system (*George*'s hydrologist cousin?). His phrase "going bottomless" in describing the design of his specialist lysimeter made the old lags think that a dodgy in-flight movie was in store.

Having established the credentials of the system Kevin demonstrated that the water use values obtained for the wetland vegetation in the lysimeter were significantly lower than Penman potential evaporation determined from an adjacent Weather Station. The results suggested that the general assumption of losses at potential rates from wetlands may not be justified.

Kevin provided **Anthony Tollow** with a definition of "soligenous" and then responded to a query from **Angela Gurnell** on the effects of wetland vegetation on hydraulic conductivity.

Steve Rose then came back on the intercom to present his paper (co-authored by **Graham Harris** and **John Williams**) on the impacts of agricultural activity on water quality. The quality of the structure and presentation of this paper subsequently brought Steve, Graham and John the award for the best paper of the Symposium. Using results from studies on six clay-land sites in southern England, they assessed the effects on hydrological response and nitrate and pesticide concentrations and loads of a range of land uses and cultivation techniques. Ploughing reduced rapid response runoff, yet also reduced the rate of vertical movement to the underdrainage. Increases in surface runoff and a deterioration in the drainage system were observed under set-aside, whilst mature woodland minimised total runoff. Autumn/winter peaks in nitrate concentration were common to all land uses with secondary spring peaks from fertilised land. The highest peaks and loads, frequently exceeding EC limits, came from arable land, particularly after conversion from grassland, with decreasing losses from set-aside and minimal losses from forest. Pesticide concentrations in excess of EC limits frequently occurred in heavy spring or summer storms. Not all of these were associated with agricultural applications. Spillages, road and verge treatment and the import of contaminated road ballast accounted for some of the worst events.

In response to a query from **Gareth Roberts** Steve indicated that it was not easy to distinguish between losses from applied and "natural" nutrients. He agreed with **John Gardiner** that compaction by farm machinery had significant effects in runoff.

The view from the window was now changing from the agricultural patchwork to upland forestry as **Mark Robinson** presented his case study on the impacts of plantation forestry on streamflow regimes. In this he compared and contrasted the perceptions of the townsfolk of Gilsland of the effects of afforestation in the Irthing catchment upstream of them with the observed changes in the Coalburn catchment in the headwaters. Local perceptions of higher sediment loads and higher flood peaks were in accord with observations during the initial stages of afforestation. The measured summer low flows at Coalburn before and after afforestation contrast with local perceptions, and indeed with those held generally in the water industry, in that they show an *increase* after planting which has been sustained throughout the first 20 years of growth. Mark attributed this unexpected result to the hydrological effects of the deep ditches ploughed in the catchment prior to planting.

In response to **Anthony Tollow**'s comment on the instrumentation on the catchment Mark indicated that North West NRA were responsible for the new design of weir now installed.

The upland forestry theme was then broadened in **Jim Hudson**'s presentation of a review of current knowledge of the impacts of forestry and forest practices on the quantity and quality of runoff, written with co-author **Jim Blackie**. Based largely on the long term IH studies on catchments in Plynlimon, Coalburn, Balquhidder and Llanbrynmair this review highlighted the effects on quantity (an initial increase followed by a reduction under mature forest), on chemistry (a small increase in nutrients compared with moorland but increased acidity), on sediment loads (increases of several orders of magnitude with peaks at planting and felling) and on stream biota (a reduction in salmonoid species). Jim also drew attention to the apparent reduction in actual evaporation losses compared to potential seen in the catchment records over the last 20 years and noted that this had partly compensated for the projected reduction in flows resulting from increased forest cover.

This point was taken up by **Rob Wilby** who wondered whether it was due to decreasing frequency of canopy wetting. Jim said records showed no reduction in frequency but some changes in seasonal distribution. **Richard Harding** commented that the reduction was apparent in grassland as well and speculated on long term drought effects on transpiration. **Hugh Goldsmith** then took us back to wetlands and the fact that on several sites actual losses there were also below potential. Could this be comment on our computations of potential rates ?. **Kevin Gilman** suggested that in many wetland covers there was a high proportion of dead, non-transpiring material.

At this point "Captain" Rodda asked to fasten our seat belts for landing, on time, and thanked the performers for the interesting and informative in-flight entertainment.

Session 3 Information Systems

Coming down to earth after the morning's flight through the environment, **John Gardiner** brought us to attention for the session on Information systems.

The first speaker was **Bryn Wilde** (in quite a different performance to his star role in the Mediæval Banquet!), who presented his paper written with **Rob Drayton** on the use of a GIS approach to rainfall runoff estimation. The aim of the project was to develop a model relating rainfall to runoff through topographic and land use parameters which could allow "what if" investigations into the effects on runoff of changed land use and proposed developments. The ability to deal with large amounts of spatially distributed data has been much improved in recent years by the use of geographical information systems (GIS) and their associated software and hardware developments. This, coupled with improved availability of remotely sensed and other spatial data allows more detailed models to be developed. The gridded data inputs to the model comprised Landsat imagery for the land use, soil types from Soil Survey maps and topographic data from an OS digital terrain model (DEM). The runoff

from each cell was estimated using a US Department of Agriculture Soil Conservation Service (SCS) model. Each cell runoff was then routed using travel times derived from the DEM to produce an outflow hydrograph. Some difficulties were found in relating the land use/soil type to the classifications required to estimate the SCS curve number for runoff (not surprising!) and further work in this area was suggested. Unfortunately hydrometric data did not become available in the project period to validate the accuracy of the model. It was felt that there were great benefits to be obtained from this type of development and a plea was made for continued sponsorship (a sign of the times?).

Mike Lowing started the short discussion by expressing some horror at the use of such an old (and foreign!) method as SCS and asked why the FSR method was not used. The project had essentially started with a review of many papers relating to work in the US and Canada, which led to the use of SCS. It was noted that the specific model used was not critical. Further discussion concerned the input of distributed rainfall and whether urban areas could be handled with the scales of input described.

The following paper by **Rod Wilkinson** initially suggested a joint, international effort but Rod assured us that STASSIS was not his co-author but a strategic supply information system (I'll leave you to decide how the acronym is derived!) which has been developed to help manage the regional water supply grid of Severn Trent Water Ltd. which serves about 80% of it's customers. Describing the back-ground to the project, three basic reasons were put forward for the need to be able to move water around - high peak day demands, loss of production from a source (including restrictions on abstraction by low flow conditions) and a need to reduce revenue costs by maximising the use of the cheaper sources. The "grid" is essentially a pipeline fed at various points. The demand centres are managed on a local basis, but the transfer of water to and around the grid is a regional responsibility and hence requires a central information system. STASSIS draws on the existing information system, where all source outputs, storage and transfers are entered on a daily basis, to process and display data in an easy to assimilate form. Future developments plan to link the system with the real time telemetry network and a costing package. A plea to the audience for any good ideas on the latter was made, with a suggestion of a suitable, liquid reward.

This was quickly claimed by **Tim Wyatt** with remarks about an optimisation package about to go live with another water company! Some discussion took place on the amount of data to be stored and, especially with relation to the "commercial" nature of things, how much would be released. A guarded "we help NRA as much as we can" brought much laughter.

In the absence of Darren Keogh or George Fleming to present their paper on the assessment of the water balance at Craigmuschat quarry landfill site using SLAMS, the session finished with **Isabella Tindall** presenting a paper on the use of GIS techniques to assess discharge consents and abstraction licences, written with IH co-authors **Roger Moore** and **Nick Bonvoisin**. The authorization of a consent or licence requires the analysis of a wide range of data types, most often spread over many systems which generally don't talk to each other. The project aim was to develop one system to handle all the data, with due regard to the processes of the NRA and the need for an audit trail. "Wonderful" WIS (Water Information System) was described as a system which attempts to solve all these issues by combining GIS with time series and other time dependent data in one system. The system essentially describes information in terms of what, when and where, with a time scale. It aims to answer general and specific queries such as "what is to be measured here?", "when are these data measured?", etc. and to enable the generation of 95%ile flows and other statistics. Overall it was felt that WIS was meeting the challenge to produce a flexible tool for the manipulation of complex and widely varying data through a GIS base.

General discussion covered topics from model grid size, fixed or variable grids, sufficiency of spatial resolution to computing ability and data input and retrieval.

This rounded off a very interesting set of papers on the way that information systems, especially when geographically coupled, are becoming essential to provide solutions to a wide range of issues.

Session 4 Floods

The session opened with **Nicole Archer**'s presentation on her work to estimate the maximum flood discharge for the extreme event on the River Tyne in November 1771. In order to estimate the magnitude of this event, floods of increasing magnitude were assessed within a 3.3km section of the Tyne at Hexham, building up the data sequentially, to produce parameters to estimate discharges for the larger historic floods. The 1771 flood estimate of $3900 m^3 s^{-1}$ far exceeds any recorded flood flow in Britain, exceeds all previous estimates of peak flood flows on British rivers, and provides an interesting and useful addition to the record of extreme floods.

Nicole's talk stimulated discussion on the estimation of extreme floods on limited, and sometimes dubious, historic evidence. **Anthony Tollow** asked about the rainfall, which must have been a tremendous amount to cause such an event, but Nicole said that there was no estimate of rainfall. **Hugh Goldsmith**, referring to his experience working on the Inverness railway bridge, said that bridge failures can cause changes in level of 0.5m. **Ron Manley** added that engineering works and deforestation can change the 'n' values for channels and flood plains: the author could not quote precise values of 'n', but they were higher than expected. **John Gardiner** had observed the downcutting since 1771 in the cross-section of Gott's Bridge (Figure 4 in the paper): this had been allowed for in the analysis. **David Archer** said that the flood had been due to intense rainfall on the Tyne headwaters; the highest was on the Wear and Tees. Newspaper reports would suggest that the rainfall in the lowlands did not imply such a high flood. The rainfall event had been extensive, according to **Frank Law**: there had been flooding in Lancashire at the same time. He wondered what risk there was that the top of thew wrack mark had been registered rather than the bottom. He went on to refer to the Allendale flood's nice marks and observed that we lack any standard. David Archer added that flood marks are more easily identified up a building, e.g. on a mantelpiece.

Andrew Black then presented a paper on seasonality and the generation of peak flows in small upland catchments in Scotland (co-author **Alan Werrity**). This re-examined the conventional view (that floods in catchments $<20 km^2$ are generated by localised convective storms) using flow records from seven Scottish catchments and three associated autographic raingauge records. Expansion of the gauging network in upland Scotland would improve our knowledge of peak generation in headwaters and thus enhance our understanding of flooding in the larger catchments to which they contribute.

Richard Cole wanted to know how the flow measurements were made: if done by current meter there could be problems with boulders. Andrew pointed out the large number of structures: on the whole he felt the data were consistent. **David Archer** felt that it was implicit that small and large catchments have different seasonalities. Andrew did have such evidence: it would have been too much to present in the time available, but would be published separately. **Ron Manley** referred to analysis he had undertaken on the Trent: monthly peaks showed that August gave the highest floods, with return periods greater than 50 years. **Rob Drayton** reported similar experiences.

David Marshall then presented a paper, co-authored by **Adrian Bayliss**,

describing work by the Institute of Hydrology to overcome the problems of estimating flood parameters for small (<20km²) lowland catchments. Out of the 53 small catchments in the Flood Studies Report, only 23 were suitable for unit hydrograph work, most of them in the uplands. 15 lowland catchments were instrumented within the 75km radius of Chenies weather radar, obviating the need for additional raingauges.

Dr Mike Hall remarked on the regression equation relating T(p) to URBAN, MSL and S1085 and reminded the Symposium that an equation relating lag time to URBAN and MSL was being used in the 1930s. His question was: when do you stop using Unit Hydrograph techniques and start using storm runoff models? **Dr Mike Lowing** said that it was very important to get the time-to-peak, but what about the volume of runoff? **Frank Law** responded that **David Boorman** at IH was deriving revised percentage runoffs. **Andrew Pimperton** asked why other regression variables, such as geology and soils, had not been considered and felt that new soil mapping could be used to make improvements.

The final paper, on modelling the effects of flood alleviation schemes in Upper Strathspey in Scotland, was presented by **Kevin Gilman** on behalf of the authors (**Dick Johnson, Roger Millington** and **Mike Acreman**), none of whom could be present. Flooding in the Upper Spey between Kingussie and Aviemore has occurred since records began in 1768. Flood alleviation measures have included extensive river embankments built in the 19th century. Water level data show no significant trend since 1952, although the cluster of large flood events since 1989 is unusual, and unacceptable to local landowners. An independent study recommended several flood alleviation measures, but the Insh Marshes (within the area) are a wetland site of special interest and the Nature Conservancy Council for Scotland (now Scottish Natural Heritage, SNH) would not accept any scheme which would reduce the water level in the marshes during low flow periods. The Institute of Hydrology modelling exercise used a river simulation model, SALMON-F, to study the effects of the proposed schemes. The conclusion was that to achieve some flood alleviation the reduction in low-flow water levels and their impact on the marginal areas would be unacceptable. Subsequently, however, Scottish Natural Heritage decided in favour of the option with the lowest impact: this has shown no appreciable drop in water level so far, and does not appear to be alleviating flooding.

Prof John Gardiner asked why anything had been proposed at all. Kevin said that it was mainly for agricultural improvement, which could in any case push the problem downstream. He told **Richard Hackett** that SNH had commissioned the work, which was reported publicly, and there was no consideration of economic cost/benefit. Any benefits of a dredging scheme would only be temporary in such a mobile river system. **Frank Law** remarked on the fact observed in the paper that the Feshie tributary floodwater backed up into Loch Insh before the Spey flood arrived, comparing that to similar effects on the Thames/Cherwell and elsewhere. **David Archer** asked if the impact of the works on downstream landowners had been looked at. Kevin replied that IH had been brought in late in the project just to look at this one area, but he assumed that the main consultants had considered this.

Session 5 Modelling Developments

After the informative, entertaining and brain-stretching activities of the preceding evening's Symposium dinner our new President called us to order for the final technical session.

The first paper of the day described the development of a GIS-based soil erosion and delivery model for the Test catchment in Hampshire, written by **Angela Gurnell** and **Peter Midgley** and presented by Angela. An USLE-type approach was adopted to estimate on-site erosion and coupled to geographical and land-use data stored in a GIS. The delivery component at this stage in the model development was based on estimates of buffer strip widths.

Applying the model in its uncalibrated form to the last 50 years produced peaks in the 1940s, associated with ploughing up pasture for root crops during World War II, and an upward trend from the 1970s onwards, said to reflect increasing cereal growth within the catchment.

Steve Wallis took us through his paper in which he reviewed aggregated mixing zone modelling of solute transport in rivers and demonstrated how accurately the approach can reproduce observed concentrations both in small streams and in large rivers.

Referring back to Pimperton and Karle's paper on the variation of roughness coefficient with flow, **Ron Manley** drew attention to the similarity between their relationship of Manning 'n' *versus* discharge and that of dispersive fraction *versus* normalised flow rate in this paper. Steve agreed that there was a connection between the conventional roughness treatment of channel flow and the AMZ concepts.

We then returned to the ecological aspects of flow with the presentation by **Craig Elliott** and **Alan Gustard** of their joint paper with **Ian Johnson** and **Terry Newman** on the River Allen instream flow requirements. They applied the Instream Flow Incremental Methodology (IFIM) to assess the impact of a groundwater abstraction scheme on trout and salmon habitat. This first application of IFIM in the UK identified trout fry as being the most sensitive indicator and indicated the minimum flow levels required seasonally at various locations in the stream.

Mike Mansell-Moullin commented on a point emerging from John Hall's earlier paper on the Trent: that upstream minimum flow requirements may be over-ridden by other requirements downstream. **Peter Midgley** queried whether habitat requirements in natural flows differed from those required under abstraction conditions: the speakers responded that no great differences should arise.

Robin Wardlaw made a heroic attempt, in the limited time available, to convey to us the complexities of his resource systems model of the Brantas Basin in East Java. This model was developed to assess the economics of alternative water resource development and utilisation strategies in Indonesia's second largest river basin. There are competing demands for water supply, hydro-power generation, irrigation and fisheries. A thorough understanding of the hydrological behaviour of the system is the essential starting point for such evaluation.

Chris Collier then took us skywards over upland England with his paper describing a new approach to estimating probable maximum precipitation using a storm model and remotely sensed data. In the proposed model, modifications are made to allow for topographic effects on convergence and solar heating. Rainfall radar data are used to give better estimates of storm totals and convergence values and satellite data are used to provide catchment characteristics. As a first indication of the power of this approach, applications to the celebrated storms at Hewenden reservoir and Halifax in 1956 and 1989 were discussed.

Richard Harding then turned our attention to the other meteorological interface in the hydrological cycle in presenting his paper on evaporation schemes for hydrological models. Starting with the Penman-Monteith expression, he reviewed the range of existing equations used to quantify transpiration, interception and soil evaporation in hydrological models.

Use of variants of these in the IHDM/SHE, MORECS and IH seasonal water use schemes was described. He noted that the choice of scheme was determined largely by the data available in relation to the objective, but advances in data acquisition techniques — and the possibility of using DTMs and remotely sensed land-use data to extrapolate to the catchment scale — meant that using more complex schemes was becoming practical.

Next **Gareth Roberts** demonstrated, in his paper on calculating the water

balance of a small catchment, that it was indeed practical to use remotely sensed land-cover information and sample plot water-use determinations to estimate catchment water use for a multi-land-use catchment. Using this approach and observed catchment rainfall produced estimated annual streamflow values within 1% of the observed flows.

In the final paper of the symposium, **Mike Hall** and **Tony Minns** gave the modellers food for thought in their paper entitled 'Rainfall-runoff modelling as a problem in artificial intelligence: experience with a neural network'. They demonstrated that neural computing, defined as training a system to simulate responses to stimuli, can produce runoff responses to rainfall inputs with an accuracy comparable to that achieved using simple conceptual models. The authors maintain that the approach requires no more computing power than the conventional approach and that the "training" procedures are less demanding than model calibration.

Will the approach take off? The audience response was somewhat sceptical. **Ron Manley** went so far as to describe it as an insult to those who were trying to understand hydrological systems, not simply pattern fitting. Work on its investigation continues: WATCH THIS SPACE!

In drawing the Symposium to a close, President **Susan Walker** thanked all those who had presented papers, complimented them on their time-keeping and commented favourably on the high standard of presentation.

It had been very difficult to decide on the recipient of the award for the best presentation. After much deliberation the decision had gone in favour of **Steve Rose**.

New Members

We welcome the following 35 members to the Society.

Baker, L.K. ..... Reading, Berkshire
Ball, C.W. ..... NRA North West Region, Warrington, Cheshire
Barlow, J.G. ..... London
Bell, V.A. ..... Institute of Hydrology, Wallingford, Oxfordshire
Birchall, P.A. ..... NRA North West Region, Warrington, Cheshire
Briffett, A.M. ..... London
Cartmell, E. ..... London
Casey, H. ..... Wareham, Dorset
Chaudery, K.J. ..... London
Clarke, K.F. ..... Glatton, Cambridgeshire
Claydon, J.R. ..... Huddersfield, West Yorkshire
Dutton, R.J. ..... Telford, Shropshire
Elliott, C.R.N. ..... Institute of Hydrology, Wallingford, Oxfordshire
Faulkner, D.S. ..... Dept of Civil Engineering, Imperial College, London
Fisentzou, M. ..... Manchester
Fisher, A. ..... Solihull, West Midlands
Green, S. ..... Institute of Hydrology, Wallingford, Oxfordshire
Hammond, C.L. ..... London
Henworth, S.P. ..... School of African & Asian Studies, University of Sussex
Lewis, D.R. ..... Institute of Hydrology, Wallingford, Oxfordshire
Loader, S.C. ..... Institute of Hydrology, Wallingford, Oxfordshire
Marouf, H. ..... Swansea, West Glamorgan
Moag, C.A.R. ..... Aspinall & Co. Ltd, Shrewsbury, Shropshire
Moore, R.E. ..... Kendal, Cumbria
Plummer, J.T.G. ..... Birmingham
Quinn, R.A. ..... NRA South West & Wessex Region, Bridgwater, Somerset
Reda, A.L. ..... London
Shaw, M.A. ..... Bristol
Spijkers, T. ..... Institute of Hydrology, Wallingford, Oxfordshire
Steward, H.J. ..... Cambridge
Stewart, F. ..... Bristol
Tompkins, J.A. ..... Dept of Civil Engineering, Imperial College, London
Turner, A.P. ..... Cwmbran, Gwent
Wade, R.J. ..... NRA Lower Severn Area, Tewkesbury, Gloucestershire
Wall, A.B. ..... NRA South West & Wessex Region, Bridgwater, Somerset

Education and Training

The BHS Education and Training Sub-Committee is currently conducting a thorough review of professional qualifications for hydrologists and of the routes and options available. The results of this review will be published in a summary article in the May 1994 edition of *Circulation*.

The Sub-Committee would welcome comments and opinions from members about professional qualifications and any issues arising from them, particularly if they might help to identify anomalies, shortcomings or requirements of the current schemes.

Members should also note the forthcoming BHS Southern Section meeting *Routes to chartered status*, to be held on 9 December at Imperial College (see *Diary*).

The 1988-92 Drought: A hydrological review

A major report on the 1988-92 Drought will be published shortly by the Institute of Hydrology. Prepared in collaboration with the British Geological Survey and with financial support from the Department of the Environment and the National Rivers Authority, the report is the latest publication in the Hydrological data UK series. Its objective is to provide comprehensive documentation of the recent exceptionally persistent drought episode and to establish a benchmark against which future periods of rainfall deficiency may be compared.

Society now places a higher premium on the amenity and environmental benefits of rivers and wetlands whilst continuing to query the cost and justification for the range of water conservation measures developed to mitigate the impact of extended periods of rainfall deficiency.

The 1988-92 drought provided a forceful reminder of the conflicting demands on the water industry and the vulnerability of the UK to unusual climate conditions. It also demonstrated the ongoing need to develop improved water management practices to withstand the twin stresses imposed by increasing water demand and lengthy periods of low rainfall.

The drought which, at one time or another, embraced much of Europe can

be traced back to the spring of 1988 in much of the English lowlands. It was punctuated by a number of wet interludes but, by early 1992 had become remarkably protracted and, in groundwater terms, more severe than any this century. Depressed runoff rates over the 1990-92 period especially were associated with a shrinkage in the river network that is without modern parallel. The failure of headwater streams - and the associated loss of amenity and aquatic habitat - was exacerbated in those areas where heavy groundwater abstraction, often over many years, had produced a sustained decline in water-tables.

The 1988-92 period stimulated reviews of water management policies in a number of countries at a time when the search for practical and scientifically based sustainable development options is intensifying. Fortunately, the drought provided many useful insights into both the scale and scope of the water resources and environmental problems caused by long term rainfall deficiencies and the strategies needed to combat them. This, of course, will be of particular significance if the extraordinary weather patterns recently experienced became a more familiar feature of our climate in the future.

The 1988-92 Drought examines the spatial and temporal variations in the drought's intensity and its severity is assessed within the perspective provided by long-term rainfall and hydrometric records. An introductory hydrological overview of the United Kingdom is given to help place the conditions experienced in 1988-92 in a suitable context. The synoptic backcloth to the drought's development is also reviewed and the European perspective is examined using selected rainfall and river flow records to index drought severity. Additionally, a short review of water resource variability in Great Britain over the featured five years - and the water industry's response to the actual and projected deficiencies - is included to help appreciate the often complex linkages between hydrological stress and water supply impacts on the community.

The 1988-92 Drought costs £20 and will be available through the National Water Archive Office: contact Shirley Black (0491 838800, Ext. 2201, or Fax 0491 832256).

Occasional Paper No. 3

Also soon to be published is the BHS Occasional Paper No. 3 on the *Assessment of Drought Severity*. Compiled and edited for the BHS by John Mawdsley, Geoff Petts and Sue Walker, this will complement the IH drought report.

News from Members

Hydrology professors

How many of you clicked your tongues in exasperation at your Editor's lapse of memory? Of course **Howard Wheater** is not the first UK Professor of Hydrology — it was **Terence O'Donnell** at Lancaster University, appointed to the Chair of Hydrology there a mere 21 years ago, and an established Chair too! [*My apologies to Terence and Howard - Ed*]

Members on the Move

Richard Boak has recently been appointed a Senior Hydrogeologist with Southern Science Ltd in Worthing. His responsibilities will include groundwater resource evaluation, licence applications, test pumping and low flow alleviation.

Richard was previously on a 2-year research contract at the University of Birmingham, carrying out groundwater resource assessment for the South Staffordshire Water Co. He has also spent several years managing integrated rural development programmes in Africa. Richard was very active in the BHS Midlands Section: his services as mini-bus driver and his regular attendance at meetings will be missed, but he will no doubt become an asset to organisers of BHS events in Sussex.

Paul Holmes, our man (and Montgomery Watson's) in Borneo, is currently living in Kuching (Sarawak) whilst working not only in Malaysia but also in Brunei, Indonesia and Singapore. The picture shows him (on the left) and colleague Tony Waterfield taking the single-vehicle ferry from Sarawak's Limbang Province to Temburong District in Brunei.



Paul Holmes returns to prohibition in Brunei with a can of a well-known soft drink (honestly)

Obituaries

Peter Bolton

We pass on to members the sad news of the untimely death of Dr Peter Bolton of the Overseas Development Unit at HR Wallingford. After a very brief illness, Peter died recently of leukaemia at the age of 40. He leaves a widow, Libby, and two young children.

A packed memorial service took place at Wallingford Methodist Church, where he was a member, on 30 September. The profession he served so well was very well represented there: Peter had been particularly respected in recent years for his knowledge of the links that sometimes exist in the Third World between water-borne diseases and civil engineering schemes.

Graham Sharp

Another name well-known in hydrology, has also sadly to be deleted from our lists: that of Graham Sharp, who died earlier this year. Graham began his professional career with the consulting engineers Herbert Lapworth & Partners before joining the Water Resources Board where he was head of the National Planning Division and responsible for *Water Resources in England & Wales*, published by HMSO in 1973.

After the demise of the WRB he moved to the Severn Trent Water Authority and was Regional Manager of Technical Services when he retired in 1988. At the time of his death he was a consultant to Howard Humphries & Partners. Graham was heavily involved in setting up the National Rivers Authority as a Technical Consultant/Director to the government's NRA Advisory Committee considering the national and regional level arrangements for the core functions of water resources, flood defence, environmental quality / pollution control and R&D functions.

Minutes of the 10th Annual General Meeting of the British Hydrological Society

Cardiff
13 September 1993

Present: Dr Mike Lowing, President; Prof Susan Walker, President Elect; Dr Richard Harpin, Honorary Secretary; Rod Hawnt, incoming Honorary Treasurer; 60 other members.

Apologies

Apologies were received from Prof Des Walling, Dr John Mawdsley and Tony Lewis.

President's Introduction

The President welcomed those present to the first AGM held in September, coinciding with the Symposium. The change to the AGM date had been made to ensure that, should the membership decide to vote down any changes to subscriptions in the Treasurer's Report, then the decision could be respected before the beginning of the subscription year; the AGM would also be better attended in September.

The main additions to the Members Handbook in the year were the Register of Independent Consultants and a new format membership listing. Two thirds of members had not replied to the request for additional information for the new listing, but the President hoped that publication would encourage others to respond.

Reciprocal membership with other national Societies has moved steadily forward, but the preparation of the Plan for the Society had proceeded very slowly. The President offered to help with the Plan 'from the back benches'.

Dr Lowing sported the new BHS tie, approved at the last AGM: ties would be on sale throughout the Symposium.

The BHS Prize this year is to be presented to the author of the best paper at the Symposium and would be announced at the close.

Minutes of the 9th AGM

The minutes of the 9th AGM, held at the University of Sheffield on 14 December 1992, had been published in *Circulation* 37. There was no discussion and Dr Jim McCulloch proposed their acceptance, which was seconded by Elwyn Jones, and the minutes were duly approved.

Report of the Honorary Secretary

The full report of the Honorary Secretary is presented on page 11.

Report of the Honorary Treasurer

Since **Tony Lewis**, the Honorary Treasurer, was absent from the meeting, BHS income and expenditure for the year ended 30 June 1993 was presented by **Rod Hawnt** (see also the Treasurer's formal report on page 12).

In 1992/93 BHS has thrived financially; the level of assets is now very healthy with £19,000 invested in a Northern Rock charities account. In summary the figures are:

Income:

1993 (9 months)	*1992 (Year)*
£16,705	**£12,914**

Expenditure:

1993 (9 months)	*1992 (Year)*
£11,402	**£ 9,262**

Surplus:

1993 (9 months)	*1992 (Year)*
£ 5,303	**£ 3,652**

Subscription levels would not change for next year: a happy 10th birthday present to members. A £5 joining fee is proposed for new ordinary members only.

The Hon Treasurer sent his thanks to **Mary McBride** and colleagues in the ICE Finance Office for all their help.

Report on Publications by the Editor of *Circulation*

Celia Kirby, the Editor, reported that during 1993 the Society's publications had included three issues of the quarterly newsletter, *Circulation*. The greater task of pre-publishing the Proceedings Volume for the *4th National Hydrology Symposium* had been successfully completed. Everything had gone smoothly.

Mrs Kirby thanked **John Griffin** for all his help in doing the 'donkey work' and also thanked all members who had contributed material for *Circulation* during the year.

There was a repeated call for new ideas for future issues of *Circulation*.

Mrs Kirby concluded by asking for help in learning how to knot her new BHS tie.

Changes to Membership of the BHS Main Committee 1992/1993

Chairing the AGM was the last duty of **Dr Mike Lowing** as outgoing BHS president. Dr Lowing said how much he had enjoyed his 21 months of office, which had been quite hectic at times.

Thanks were given to the main committee for their support and also to the President's "sponsors", Montgomery Watson. It had been an honour to serve as President and, although he thought he had not achieved as much as he wanted, he hoped that the Society had been taken forward along the lines laid down by its Founder President, **Mike Mansell-Moullin**.

With the recent introduction of a system of having a President-Elect for a year, **Dr Susan Walker** would be well geared up to assume the role of President from the end of the AGM.

The two successful candidates for the elected committee members were **Professor Paul Jowitt** and **Dr Hilary Smithers**: they were each given a round of applause. The President thanked the two unsuccessful candidates for standing and expressed his hope that they would not be deterred from standing for election to the committee in the future.

Rod Hawnt, being the only candidate nominated, succeeds **Tony Lewis** as Honorary Treasurer.

Changes to Statutes

The proposed changes to the Statutes had been carried in the postal vote by 51 votes to 2. The changes reflected a committee recommendation to raise the upper age limit of younger members qualifying for concessionary subscription rates from 21 to 25, tidied up some slightly obscure wording, and confirmed the decision to make the AGM formally responsible for confirming proposed changes in fee structure.

The new statutes would be issued to members as soon as possible.

Any Other Business

A letter had been received from a retired member **James Robertson** asking the AGM to consider the question of life membership. It was agreed that the AGM would empower the main committee to examine the question for members aged 62 or over. If the principle and a suitable figure were agreed, it would be enacted immediately with effect from 1 October 1993. Mr Robertson would be advised accordingly.

President's Address

Dr Susan Walker gave an Address to the AGM on her inauguration as BHS President for the next two years. In the address Dr Walker looked back over the last ten years to see where the Society started from, and looked forward to see where it should be going. The Presidential address is included in the new President's Piece on page 12.

Richard Harpin
Honorary Secretary

10th Annual Report of the Hon. Secretary

In this annual report of the Society's activities, it is very pleasing to report the continued strengthening and development of the BHS, especially as we are now at the end of our first decade.

The society currently has 637 paid-up members. This is 7% higher than the equivalent figure of 598 for last year (the figure of 586 reported at the 1992 AGM was slightly in error), marking a small increase in membership and a stability in numbers which demonstrates the society's maturity. A further 46 members have not paid their fees.

Our programme of scientific meetings continues to be the main focus of BHS activities. This year topics for national meetings have ranged from Land Use Change Impacts, to the Workshop on Hydrometric Field Techniques, and Rainfall-Runoff Models. The Field Techniques Workshop was well attended, with about 90 delegates, which I feel confirms the need for a practical element in our meetings to complement the art and science. The Southern Section's programme of regional meetings has again been well supported. The Midlands Section is now well established and the Pennines Hydrological Group of ICE has now become a BHS section: both have a strong programme in place. In the South West **Peter Sims** has been battling against the problem of sparse membership, but I hope that members there will make a special effort to support meetings. The Welsh and Scottish Hydrological Groups of ICE have also remained very active. I should like to thank the organisers in advance for the 4th National Symposium, particularly **Jim Blackie** from IH. We have a very interesting programme before us. Progress on the 5th National Symposium is advancing and we already have the venue arranged: it will be at Heriot-Watt University in Edinburgh during September 1995. It seems to me that this location reinforces our commitment to a truly British society, rather than being centred mainly on the south-east of England.

We will continue to add to the Members Handbook, first issued last year. Some updates have already been circulated, and I was particularly pleased to see the first edition of the Register of Independent Consultants in Hydrology sent out with the last issue of Circulation. I feel that the register will prove very useful, not only to companies such as my own, but also to individual members who are asked to make recommendations. Any other members who would like to be included should contact **Louise Picton**, c/o ICE. 290 replies were received to the questionnaires asking members for more detailed information for inclusion in the handbook. The type of information requested reflects members' wishes expressed in the previous questionnaire reported by **Rod Hawnt** in *Circulation 35*. I hope that even more members will be able to provide fuller details in future, and I would also make a plea for ideas for new elements to go into the handbook.

The date for this year's AGM has been brought forward from December to September to bring it in line with the subscription year which starts in October. The change in the timing of the AGM will give members the chance to vote on any increase in subscriptions.

Despite the fact that this has been a "short year", the standing of the society has advanced considerably both through continuation of general activities, such as our programme of national and regional meetings, and also through several initiatives. One of these is the change to the International Liaison Sub-committee which now meets on an annual basis outside the main committee: its first meeting under the new arrangement was held in October 1992. The sub-committee is charged with advising the main committee on all matters relating to international hydrology and on the role we can play in furthering the international standing of British hydrology and the British Hydrological Society. **Jim McCulloch** is in the chair and is assisted by representatives from IAHS, EGS, IAH and IAHR, besides BHS.

Past presidents have been responsible for establishing a number of bilateral links with other hydrological societies: **Allan Lambert** was particularly enthusiastic and we are very grateful to our outgoing president, **Mike Lowing**, for his efforts in following this up during his term of office. I am in no doubt that the idea to organise a major international symposium, which has been put forward by the sub-committee as a long-term objective, will be of great benefit in confirming the international standing of the BHS.

In the meantime the policy of reciprocal membership with other national organisations, such as those recently arranged by Mike Lowing with the newly-formed Canadian Society for Hydrological Sciences, with Russia and with South Africa, and the continuation of friendly correspondence with societies such as the Nordic Hydrological Society (with whom we are discussing joint sponsorship of the 5th BHS Hydrology Symposium), will continue to reap benefits and promote the BHS worldwide. Dr Cramer from the Netherlands is attending the 4th National Symposium, and I understand that he is keen to discuss international liaison with BHS. We are also very fortunate that Dr Starosolsky, President of the Hungarian Hydrological Society, is to deliver the keynote address.

A second, more recent, initiative arose in response to the perceived need for a stronger and more unified voice for hydrological research. To meet this need the BHS has convened a Research Sub-committee under the co-chairmanship of **Frank Law** and **Howard Wheater**. The sub-committee starts with an impressive list of members, including no fewer than six professors active in hydrological research in Britain. An early conclusion of this sub-committee, which met for the first time in April this year, was that it should formulate a Research Strategy document which would identify research needs and place them in a context which would be readily appreciated by senior staff in research funding agencies. This document is expected to be influential in forming a new framework for hydrological research in the UK and hopefully in achieving the necessary funding. Some members will have received a questionnaire to help identify the key issues which need to be resolved to allow progress to be made.

A third initiative, by Mike Lowing, concerns government consultation procedures on water related issues. Government departments produce consultation documents which are circulated to all organisations and individuals who are thought likely to respond with helpful opinions. Although the BHS has been invited to make such comment on water-related affairs on one or two occasions in the past, we do not appear in general to have been registered as an obvious recipient for consultation. We have had a favourable response in our recent lobbying of government departments, such as the DOE, MAFF, NRA, the Scottish and Welsh Offices, and it is now much more likely that BHS will be asked to be involved as an independent voice on hydrological issues in future consultation procedures.

Following analysis of the questionnaire reported by Rod Hawnt last year, the education and training sub-committee decided that representation of younger members (defined as "under 30"!) on the main committee was desirable. The average age of the main committee was substantially reduced with the election of "young blood" — **Dr Kevin Tilford** (Salford University) — in January. In addition **Jennifer**

Taylor (South West Region NRA) joined the committee as a co-opted member. To ensure that this continues it is proposed that there will always be an elected young person's representative.

I would like to record again our thanks to the former secretary to the BHS committee, Peter Bacos, who was replaced by Louise Picton earlier in the year. I would also like to thank departing committee members for their efforts, particularly the retiring President, Mike Lowing, who has done a splendid job and has certainly given me an easy time by taking on himself many tasks that I would have expected to perform, and the retiring Honorary Treasurer, **Tony Lewis**. Finally I would like to welcome our new Honorary Treasurer, Rod Hawnt, and the new President, **Professor Susan Walker**, who I am absolutely certain will bring to the position the same devotion that she has shown in her previous committee roles.

Although the scope for increasing the membership is obviously limited, I am positive that if we continue to support the Society's activities and to review and update them periodically then the Society will continue to grow in numbers and in stature, both nationally and internationally. Finally, I am equally sure that we can look forward in our second decade to similar successes to those achieved in the first.

Dr Richard Harpin
Hon Secretary

Annual Report of the Hon. Treasurer 1992/1993

The 1992/93 financial year has been a '9 month year' ending on the 30th June 1993 with a balance in the BHS account of £21126, compared to £15823 last year. This represents a surplus on the 9 months' operations of £5303 compared to a budgeted surplus of £850.

Again, as for last year, it has proved difficult to ascribe any one reason to this exceedingly good outcome. Membership rose by 14% to 683 "active" members; there was significant additional income from seminars, publications and deposit interest. Every effort has been made to control our costs.

BHS has thrived financially in 1992/93 with a pro-active membership at national and regional levels as shown by the number of events and what should be a very successful and enjoyable Cardiff Symposium.

The proposed subscription for 1993/94 has been held at last year's level. For new full members only, it is proposed to introduce a joining fee of £5. The fee is to cover the fixed costs of the membership directory and will be waived if people adopt a direct debit method of payment, subject to the ICE membership system being able to cope. In addition, it is proposed to change the statutes to raise the age limit to 25 for the concessionary student rate.

So, its a happy 10th birthday present to the membership, both on the subscription payment and on the very healthy level of assets that the BHS has achieved since its inception, with over £19,000 now invested in a Northern Rock charities account.

As the retiring Treasurer it is very pleasing to be leaving the post with the society in such a healthy state. I would hope to see the committee undertake further new initiatives in the coming year to encourage Hydrology at all levels.

In conclusion I would like to thank Mary McBride and her colleagues in the ICE Finance Office for their help and support, without which the treasurer's task would be impossible, and the committee for their very constructive input to the debates on matters financial. I look forward to being able to continue to serve BHS in my new role at the Pennines Hydrological Group representative on the committee.

Tony Lewis
Hon. Treasurer

The new President's piece

I am delighted and honoured to take over the Presidency. As a founder member of the Society I am particularly pleased to hold the reins following the 10th Anniversary of the founding of BHS. Our second decade began in style with the 4th National Hydrology Symposium in Cardiff. Those of you who were there will agree, I am sure, that it was both technically stimulating and enjoyable. Our thanks must go to Rob Drayton, Jim Blackie, Celia Kirby and all the organising team for making it such a success. Those of you who couldn't attend, Heriot-Watt University will host the next Symposium in September 1995, so book early for Edinburgh and start practising making paper aeroplanes now!

A highlight of Cardiff, which indicates our status as the focus of hydrology in the UK, was the opportunity to welcome several eminent overseas guests:

Dr Andreas Szollosi-Nagy, Director, Division of Water Sciences, UNESCO
Dr John Rodda, Director, Hydrology & Water Resources Department, WMO
Dr Henny Colenbrander, General Secretary, IAHS
Dr Wennemar Cramer, President, Netherlands Hydrological Society

We were also delighted that Anthony Tollow could join us again. Anthony has been a strong supporter of BHS and has travelled all the way from South Africa to attend each National Symposium.

The Cardiff AGM was an appropriate occasion to begin to take stock of the Society. It provided a useful landmark from which to look back over the last ten years to see where we started from, and look at where we should be going in the future.

Following the Exeter conference in 1982 and the excellent work done by the initial planning group under the leadership of Mike Mansell-Moullin, the Society was launched with an inaugural meeting in the Royal Society meeting rooms in November 1983. At that time, we had about 280 members who looked to the Society to provide a forum for bringing together the scientific and the engineering aspects of hydrology: a Society which was national, which was available to members in the provinces as much as those who lived and worked in London; a Society which was open and friendly and which was responsive to the needs of its members; with time it would be seen as the recognised voice of hydrology in the UK.

In 1983, Mike Mansell-Moullin said that the forming of a new society was an "act of faith". Looking back over the last ten years, that faith has been rewarded. He expressed concerns that the different factions in hydrology could pull the Society apart, but I think we will all agree that this has not happened.

We have members from across the spectrum of backgrounds:

$^1/_3$ civil engineers

$^1/_3$ geographers

$^1/_3$ other disciplines, e.g. environmental science, physics, maths

We have members across the spectrum of employers:

¼ in the water industry

¼ in consultancy

¼ in academic institutions

¼ in other activities, such as the Institute of Hydrology, local and central Government.

Whilst 50% of our members work wholly in the UK, a surprising proportion do some work overseas and we have a healthy number of members living overseas.

Our membership is spread through-

out the UK and the Society makes great attempts to be "available" to its members, by limiting the number of meetings held in London and by moving its national meetings around the country, by having Regional Sections and by supporting the Welsh and Scottish Hydrological Groups of the ICE.

We like to be available and approachable and one way of doing this is via *Circulation*, which, over the years, has been a credit to Celia and her team at IH. From the Questionnaire responses, it is very clear that this is one of the most popular outputs of the Society. The Committee is always keen to hear from members about what sort of initiatives they would like us to follow up. Recent initiatives which have picked up the ideas of members include the holding of workshops on practical applications, designed to appeal to the less office-bound. The recent hydrometric workshops were a notable success. The impetus given on Education and Training and discussions which have gone on with ICE, IWEM and the Royal Met Society covering the route to Chartered status were initiated in response to members who had had difficulty in following the various accreditation routes. Whilst significant steps forward have been made, this work is still ongoing and will continue well into the next ten years.

Ten years ago, we looked to become, with time, the focus of hydrology in the UK. I think we are well on the way to achieving this. For example, our comments to Government on the proposals for the privatisation of the water industry and on their proposals for an Environmental Agency have been well received. We have strong links with EGS and IAHS and reciprocal arrangements with many of the overseas hydrological societies, and the Royal Society now recognises the Society as the focus for hydrology in the UK.

As we move into the second decade, the time has come to review the Society and its direction. Should we be consolidating? Should we be trying to expand? What particular issues should we address? Mike Lowing has started this process as he is currently producing a handbook — primarily for committee members — which pulls together the experiences of the last 10 years into a sort of operational manual. This will explain in practical terms what we do and how we do it: e.g. how to organise a National meeting; a guide to being Hon Treasurer. Mike expects to finish this in the next few months.

Going on from here, I would like the Society to start looking forward and produce a strategy for the future. I expect the Committee to begin working on this shortly. It is now fashionable in most organisations to look for VFM (value for money). I don't think our members are any different: they also will be looking to see if the Society provides them with VFM. Whilst our subscriptions are only modest, I don't think we can rest on our laurels. It is important to decide whether we should continue to give attention to those issues we have covered in the past:

- Is there more to do on Education and Training?
- Do we need to develop close links with European hydrologists?
- Can we develop close links with other UK learned societies without losing our independence?
- Can we do more for younger members?

These are the sort of questions we will be asking over the next few months, and the Committee would welcome your views.

Please do not hesitate to contact me or any Committee member on any of these issues or to let us know if there is anything else we should be doing to meet your requirements.

We have come a long way from those faltering beginnings in 1983. This would not have been possible without the help and support of a large number of organisations and individuals. I cannot mention them all, but I must single out

- The Royal Society, for their initial and continuing support.
- The Institute of Hydrology, who provide a significant contribution in terms of staff time - I have already mentioned Celia and her *Circulation* team - and support in organising our National Symposium and other meetings, as well as providing a regular attendance at our meetings.
- The Institution of Civil Engineers who provide our administrative and accountancy support.
- Employers who allow staff to spend time attending technical meetings, being on committees and generally to contribute "in kind".
- Particular individuals, because those who take on committee roles cannot do it all in work time. They, especially officers of the Committee, put in much of their own time for the benefit of the Society.

Individuals often spend time acting on behalf of the Society over a number of years, and this brings me on to our retiring President. Mike Lowing was a member of the very first BHS Committee and throughout the ten years he has been a key player in BHS: as an active member, as a Committee member and as an organiser of the first National Symposium (Hull, 1987).

He was, almost single-handedly, responsible for the Membership Directory and the Register of Independent Consultants. Last, but by no means least, he has been our President for the last two years. Mike has carried out all these tasks with great enthusiasm and energy.

In closing, I would like to thank Mike for his efforts over the last ten years and say a personal thankyou from the Committee for the way he has kept us all in order during the last two years with such good humour.

Susan Walker
President

BHS Ties

No well-dressed member can afford to be without one of these elegant additions to the wardrobe. The ties are made of Jacquard woven deluxe polyester (so says the manufacturers' blurb) in a discreet (*my definition - Ed*) shade of dark blue, with the society's logo in two shades of pale blue and white strategically placed so that it comes just below the knot and will therefore show above a waistcoat or V-necked pullover.

At only £6.50 each, surely the best buy of the year! To get yours, please make your request, complete with money/cheque, direct to Louise Picton at ICE (address on back page).

For those members for whom a tie is not an essential part of their sartorial kit, we are investigating an enamel lapel pin, which will probably be available for approximately £3.00: more details in the next *Circulation*.

Travel grants

Grants in the range £75-£100 are available to help members with the cost of attending meetings (see *Circulation 38*). The scheme is open to anyone, but is intended mainly to help students or younger members whose travelling expenses are not met by an employer.

Please apply to the Hon Secretary (**Richard Harpin**), including details of the meeting, whether a paper or discussion is to be presented, the total costs and benefits of attendance, brief details of your financial situation, your background and your aspirations in hydrology. A brief supporting letter from a supervisor is also required.

Successful applicants are expected to produce a short report of their experiences in attending the meeting.

Water supply and demand in the south-east: recent drought experience

BHS Southern Section Meeting
Institute of Hydrology, Wallingford
20 January 1993

Over 70 people attended this meeting on water resources in southern England, jointly organised by BHS Southern Section and the British Section of the International Association for Hydraulic Research. The meeting, chaired by *Dr Nigel Arnell* (Institute of Hydrology) heard presentations on the 1988-1992 drought and the water industry's actions before, during and after the drought.

Terry Marsh (IH) began the meeting by reviewing the 1988-1992 drought.

The UK is a small country with great spatial variation in rainfall (more than 5000 mm per annum in parts of Scotland; less than 650 mm in the south-east). Taking the effect of evapotranspiration into account, average effective rainfall can be as low as 200 mm in the lowland south-east. Unfortunately this is the area of most intensive demand; with constantly growing needs, this means increasing vulnerability to drought.

Across the whole country the 1988-1992 rainfall was within 2% of average. This masked 20% above average falls over much of Scotland and a deficit of up to 30% in parts of the south-east. In some areas this drought deficit was unprecedented in length and severity.

The drought led to 40-60% runoff deficiencies with some flows being the lowest in 100 years by winter 1991-1992. Often the 1976 low flows were not exceeded, but the long period of low flows has caused significant changes to flow duration curves, where records are only 25-30 years long. Groundwater levels were even worse, with recharge as low as 30% of average in some areas. This has led to an almost unbroken recession, with aquifer levels in uncharted territory by 1992.

Environmental and amenity repercussions have been great, with massive reductions in stream network. Imposing increased abstraction upon the climatic effects has often made matters worse.

The past few months have seen spectacular recoveries except in the worst-hit parts of East Anglia and Kent.

Ben Piper (GU Projects) commented that the Water Companies had worked closely with the NRA to ameliorate the effects of abstraction: it is difficult to maintain service standards and the environment.

Terry said that given the longevity of the drought, compared with the rapid recovery after 1976, it may be necessary to re-examine the balance between abstraction and the environment in some cases.

Dr Alan Gustard (Institute of Hydrology) reviewed recent developments in assessing drought return periods.

Drought assessments were illustrated, based on the analysis of time series of rainfall, river flow, groundwater levels, groundwater recharge and river ecology, each providing different estimates of drought frequency.

Unfortunately, complete time series of daily flow data were only available up to the end of 1991, and a detailed assessment of the current drought cannot be carried out until the end of 1993.

In using rainfall data, the start date, duration and areal extent of the drought must be considered. There is, moreover, limited practical value in using rainfall data in isolation and the analysis should be linked to such factors as hydrogeology to estimate groundwater recharge. Problems of using rainfall data include accuracy, temporal change and different periods of record. By standardising data and producing regional frequency relationships the use of Tabony tables overcome some of these problems.

Although both groundwater levels and recharge can be used to assess drought frequency, problems may arise, including measurement errors, pumping effects and very flat frequency distributions of minima. River ecology can also be used as a drought severity index, defined by the available habitat for a given species and life-stage. However, interpretation (and particularly extrapolation) of such frequency plots must be made with care.

In conclusion Alan said that firstly the drought event must be defined precisely, secondly this must be linked to start time, duration, yields and species (where appropriate). Thirdly, the sensitively of frequency estimates to short records, hydrometry and artificial influences must be considered. The use of rainfall data has the advantage or reduced errors associated with the data but the disadvantage of less direct relevance to water resource issues. In contrast, the use of more direct and relevant drought measures for example, ecology or recharge have a greater number of estimation problems associated with them.

The discussion that followed ranged around the use of these various drought indices. **Mike Mansell-Moullin** argued that because we cannot forecast drought operationally, rainfall data is sufficient for estimating drought frequency. The more complex forms of analysis are only useful for looking back at a later date after the event is concluded.

Geoff Burrow asked whether the 1988-1992 period formed an outlier in the drought sequence. Alan replied that a comprehensive analysis awaits the evaluation of all 1992 data and it may be premature to assume that the current drought is over, particularly in the context of long duration events and groundwater recharge.

The meeting then turned to the water industry's response to the drought, and **Mark Potter** (Southern Water) began by reviewing drought operation experience in the Southern Water region, and in East Kent in particular.

Mark said that his view of the drought in East Kent was governed by level of service indicators and the balance between the environment and his 600,000 consumers. 70% of his sources are groundwater and the remainder river/reservoir. Because of the duration of the drought, all sources were affected. His actions were in four main areas.

When a drought becomes a problem, action is often reactive, as the final depth/duration is always unknown. Although rainfall has been around 70% of average, winter rainfall has been particularly low, with poor recharge and an inability to fill the main pumped storage reservoir.

Once the drought has been identified, supply problems must be dealt with. Refurbishment and marginal sources can improve availability, and normal operations must be reviewed. In Kent groundwater sources traditionally supply baseload demand and Bewl Water supplies the peaks. Over the last few years this has been turned around

because of critically low groundwater levels. This can then be coupled with greater effort on leakage reduction and ultimately drought orders/restrictions: almost 40 orders were issued in his area over the last four years.

Demand suppression can then be considered by improving customer awareness through media campaigns and hosepipe bans (which can be obtained in three days). These can result in 10-15% average day reductions and up to 20% on peak days. Non-essential-use bans can take up to three months to obtain and are therefore much less useful. Finally initiatives such as Leakline (burst reporting), Spraywise and leafleting can all bring benefits. One implication of this is that the whole Company is involved, from supply and distribution to legal and customer services. With this level of involvement a consistent approach is important.

For the future, the Company must consider the time required to build up the existing deficits, and the design implications of the need to plan for durations of 2-3 years. Whilst supplies have been met, more severe droughts will occur and they must plan for unrestrained demand prior to restrictions in a 1-in-50-year drought.

Questions then ranged around whether Leakline would continue (undecided), reservoir control rules and the definition of droughts. **Howard Wheater** asked how worried the Company were at the end of summer 1992, with levels still dropping. Mark said that by then resource levels had stabilised with the effect of restrictions, publicity and the end of the summer. The concern was there, but no further action was required at that time.

Terry Marsh asked whether groundwater yields had declined as levels dropped into uncharted territory. Mark said that through pump lowering and demand suppression they had no experience of this.

Graham Warren (NRA Southern) then went on to review the NRA's actions, under the headings of drought characteristics, resources implications, NRA actions and, finally, lessons for the future.

Chalk is the principal NRA Southern aquifer and over the last few years there has been a reduction of up to 50% in effective rainfall from Hampshire to Kent. In parts of Kent recharge has possibly been as low as 40% of average. This left a cumulative rainfall deficit in December 1992 approaching 400 mm in East Kent.

The resource implications of this are that groundwater levels have dropped from 1988 onwards. There has been no substantial recovery in the East until the last few weeks. As may be expected, recovery is particularly poor in the major public water supply abstraction areas. Resultant low flows have caused difficulties in river abstraction and in the filling of pumped storage reservoirs.

NRA actions have revolved around protecting essential supplies, securing fair distribution and preventing unlawful derogation. With the large number of Companies in the Region, effort has gone into coordinating action and encouraging a uniform response.

Demand management has been attempted through publicity, restrictions, abstraction monitoring and moratoria on new applications. Augmentation has also been used to protect rivers.

Looking to the future, we must consider whether rainfall is decreasing. Some source yields have been marked down over the last few years and more may follow. In East Kent demand is approaching 75% of effective rainfall. Decreasing rainfall could match this increasing demand. We must reduce demand, wastage and groundwater dependence, improve distribution and use drought recharge as a basis for abstraction control.

Discussion then ranged around augmentation and artificial recharge and the problems of EC Directives on discharges to ground — even river water might require treatment! Reductions in groundwater dependence could be achieved through greater use of pumped storage reservoirs and trunk mains from the wetter west of the Region.

Terry Marsh asked whether twice the average rainfall would be required to reattain levels: he would not wish this upon anyone. In 1976 120% average had given recovery: why was Kent so severe? Graham felt that it was the combination of drought and groundwater abstraction, operating so close to the safety margin, which was causing the problem.

After lunch the meeting turned its attention to the alleviation of future droughts. **Geoff Burrow** (NRA Southern) presented the NRA Southern regional strategy, which is the culmination of work which began with the inspector's refusal of a reservoir at Broad Oak in Kent in the late 1970s. Given the difficult balance between demand and the environment in the south-east, we must begin to take difficult decisions now to get through even the next 30 years.

Whilst the annual effective rainfall across the region averages 300 mm, the 1-in-50-year figure is about 100 mm. Current authorised abstraction (including non-consumptive) is around 90 mm. To balance this we must forecast growth, when in general our knowledge of true use/loss levels is poor. Southern Region has some advantages in this area through the network of water-use monitors on different housing categories. These have provided continuous records of household consumption in some 40,000 houses since 1986.

If current demand forecasts were realised over the next 30 years, demand would exceed the 1-in-50-year rainfall. The drop in use through drought/recession may mean that we have a longer period before a deficit occurs. If the environment is to be maintained, action must take place on domestic metering, leakage control, optimisation of resource use and sensible development of new resources (not just to fuel further demand). The key issues are domestic metering and leakage control coupled with reasonable resource developments.

Discussion ranged around metering cost/problems and the effect of leakage. Is all this water a lost resource? **Geoff** said that the bulk of the population is coastal, so that most leakage in the Southern Region is lost to the sea.

Ed Matthews and **Rob Brown** (W S Atkins) concluded the meeting by discussing inter-basin transfers.

W S Atkins have been awarded several NRA Contracts to study the engineering feasibility and environmental implications of some of the inter-basin transfers illustrated in the National Resources Policy document. In particular they were considering Trent to Anglian and Thames, Lower Severn to Thames, and Severn to Upper Trent. Maximum transfers might be in the range of 300 to 600 Mld^{-1}.

Some of the operating/engineering constraints were outlined by Ed, including the use of existing channels where possible, environmental effects, route constraints and methods of transfer. Tunnels were generally uneconomic compared with pipelines, except in some cases of estuaries and SSSIs. Headworks, pipes and discharge arrangements are being considered, along with the costs of increasing channel/canal capacities to cope with increased flows. Some seasonal/operational storage would often be required as well.

Operational aspects include the need to minimise transfer losses by abstraction and other factors, flow forecasts in the donor/recipient rivers, plus control of abstraction and quality. It is also important to consider the ecological aspects of habitat, sediment flushing and migratory fish patterns in assessing a transfer of this size.

Questions on transfers ranged from the criteria on the duration curve used to assess effects on the receiving water to the possible adverse quality and biology effects of both waters. **Mike Price** was interested in the percentage of mean flow that the discharge could represent on the Thames: assessments have been made for transfers of up to 40% of the mean flow. The implications of the wastewater directives and environmental cost assessments of the schemes also received an airing.

Peter Midgley

Whence and whither the BHS internationally ?

by Jim McCulloch

The wide variety of papers, posters and equipment presented at the 4th BHS National Hydrology Symposium at Cardiff last month is encouraging proof of the vigour and future potential of the British Hydrological Society as a learned society in its own right. At the meeting, the tenth anniversary of the Society, backward and forward perspectives of BHS were proposed, in marked contrast with the thoughts in Robert Burns' address To a Mouse:

> Still thou art blest compar'd wi' **me**!
> The **present** only toucheth thee:
> But Och! I **backward** cast my e'e,
> On prospects drear
> An' **forward**, tho' I canna **see**,
> I **guess** an' **fear**!

How much more fortunate are those, charged by the BHS with retrospective and forward looks on behalf of a Society created just before the Royal Society abandoned Hydrology, so that an early opportunity occurred which BHS was ideally suited to exploit! Thus, any backward glance will indicate, not only steady growth and growing support but, above all, enthusiasm from the hydrological fraternity of whatever basic discipline; the forward look is something to which all the membership must contribute. Indeed, the past, the present and future of the BHS depends entirely on the energies of its office bearers and of its individual members.

In 1956, the late Frank Law, Engineer to the Fylde Water Board, quantified in hard financial terms as well as in cusecs, the gradual loss of the water resource in his (afforested) catchment as the Forestry Commission's trees developed to canopy closure. This linkage between blue skies science and economic resource allocation gave a new priority to the emergent science discipline of hydrology. This impetus led to years of committee work to prepare the case for allocation of resources to catchment area experimentation in Britain. Such work was not original and precedents had even been set in developing countries.

Indeed I was part of Charles Pereira's team in East Africa which established, operated and published the results of four series of catchment experiments on 10 individual catchments between 1956 and 1962.

However, it was not until 1962 that the Hydrological Research Unit (HRU) was established at Wallingford by the Former Department of Scientific and Industrial Research (DSIR). In 1966, when the Unit comprised about ten graduates, a Quinquennial Programme for Hydrological Research was published in the HRU Record of Research; at the time, it seemed a formidable document.

How could such a small organisation as the HRU possible undertake such an all-embracing programme of research in hydrology? However, from such small beginning the Institute of Hydrology (IH) sprang; itself now 25 years old, it is a vigorous and, above all, adaptable multi-disciplinary research organisation, capable of undertaking not just a limited research programme of the type originally conceived but a remit of fundamental and applied research vastly wider than anything envisaged by the DSIR's Committee on Hydrological Research or indeed by the successor Hydrology Committee of the Natural Environment Council.

On the occasion of the formal opening of a further extension of the original IH building and of the largest mainframe computer then installed in NERC, I presumed to comment that the greatest advance in research in hydrology in more recent years in the UK had been the creation of the BHS as a learned society in its own right, by the common consent of representatives of all the relevant component disciplines of hydrology and water resources. Just as IH has matured and come of age, so at ten years of age, the BHS had progressed far more than might have been expected at the outset; it has established, through the support and voluntary efforts of its members, a unique niche in the hydrological community in Britain.

As the BHS has grown and developed, it has appointed sub-committees to investigate relevant areas for future advances. The BHS Research Sub-Committee, led by Howard Wheater and Frank Law, is currently preparing a Research Strategy Document with the intention of influencing funding, both nationally and internationally for hydrological research. The International Liaison Sub-Committee is charged with developing links with appropriate hydrological societies overseas. Some encouraging responses have resulted, particularly with the NHA (Nordic Hydrological Association) as well as with the Netherlands and Hungarian societies.

However, while there are no difficulties in arranging exchange visits, joint symposia or meetings with such overseas societies are more problematic, largely because of difficulties in communication. Senior personnel in these countries seek, just as we do, to allow their young hydrologists to take their first steps in public speaking and presentation of their scientific results in the familiar atmosphere of their national society and in their native language. Thus, at the NHA, the Danes speak Danish, the Swedes speak Swedish, the Norwegian speak Norwegian and the Finns — well, few of the other Scandinavians speak or understand Finnish (which is unrelated to other Nordic languages) so the Finns speak English, which, in any case, most Scandinavians understand remarkably well.

Just as it appears that it may be difficult to resolve the conflict of national language versus international communication, the solution has arisen through the European Community. Since we are all European, we can meet on an equal basis at the European Geophysical Society, where few problems of communication arise, because each national group (except the English-speaking peoples!) speaks English. Spurred on by the enlightened enthusiasm of Enda O'Connell, the EGS Vice President for Hydrology, the Hydrology Section of EGS was established in 1991 and has become one of the best-attended and most vigorous of the sections of the EGS. Indeed, this

year it was the turn of Hydrology to provide the President of EGS for a two-year appointment. Dr George Vacheau (of Grenoble) was chosen by ballot of all the members paid up at the beginning of the year; his appointment is particularly appropriate as next spring the annual EGS Assembly will take place at Grenoble.

While all geophysicists are welcomed at the EGS, members of the BHS have a unique opportunity, gained through the skilful negotiations of former BHS President Allan Lambert. Firstly, as members of BHS, they may join the EGS at a substantial discount and share in the lively exchanges at the annual Assembly. Secondly, as members of EGS, they are free to purchase approved EGS publications at a substantial discount on the corporate price paid by libraries and institutions.

Of course, to ensure the continuing viability of the publications, the publishers insist that individuals may purchase such heavily discounted journals only if the library of their employing university or institute subscribes. Finally, in extended negotiations with which I was involved as the British Managing Editor of the *Journal of Hydrology*, EGS have recognised the *Journal of Hydrology* as one of its official journals. Six Associate Editors have been nominated to the Editorial Advisory Board by the EGS Hydrology Section and, in addition to the ten normal 400-page volumes, it is intended to publish each year two EGS Special Issues comprising about 48 papers and 800 pages in all, containing material originating in presentations at the EGS assembly and revised after international peer review.

The British nominees are:
Dr James Bathurst, Civil Engineering, University of Newcastle-upon-Tyne
Dr Richard Harding, IH, Wallingford

They join:
Prof Ian Calder, IH, Wallingford
Dr Colin Neal, IH, Wallingford
Prof Enda O'Connell, Water Engineering, University of Newcastle-upon-Tyne
Prof Jim Shuttleworth, formerly IH but now at the University of Arizona.

Recent and forthcoming Special Issues based on EGS material are:

Neal & Hornung, 1990. Transfer of elements through the hydrological cycle: EGS Barcelona 1988

Feddes & Kabat, 1993. Modelling flow and transport in the unsaturated zone: EGS Wiesbaden 1991

O'Kane. Mesoscale hydrology and the GCMs: EGS Wiesbaden 1991 - *presently under review*

Armstrong, Raats & Wheater. Field and laboratory techniques in hydrology: EGS Edinburgh/Wiesbaden 1992-93 - *presently under review*

Bathurst. Sedimentation-channel deposition processes and interpretation of sediment yield records from lake and reservoir deposits: EGS Edinburgh 1992

Teutch & Fernandez. Groundwater: EGS Wiesbaden 1993 - *in preparation*

Harding, Jochum & Laval. HS8/OA15: Edinburgh/Wiesbaden 1992-93 - *in preparation.*

Clearly the editorial load, both for the (volunteer!) Guest Editors and for the Managing Editor is substantial, but the stimulation of ideas and results following the interaction of peers at the EGS Assemblies is its own reward. BHS members may well reflect that the British representation on the Editorial Advisory Board and the subsequent involvement with these Special Issues emphasises the standing of Britain in the international literature as well as the impact of British scientists on advances in hydrology and water resources.

During one of the discussions at Cardiff, an eminent British hydrologist, now occupying a Chair overseas, remarked on the substantial cost of the *Journal of Hydrology*. While it is true that an annual subscription price of $2500 makes a heavy inroad on an institutional budget, the follow-on price to individuals within such an institution, about £150 for twelve 400-page volumes, is so modest that it is not unreasonable for senior staff in a variety of departments to subscribe as individual members of EGS.

We, unlike Robert Burns's mouse, are equipped to look into the future. Whilst there are likely to be some happy prospects ahead for hydrology, we must also foresee and overcome difficulties. The late Frank Law's utilitarian vision led to the expansion of investment in the hydrological sciences. Yet too narrow a definition of short-term gain may be restrictive and may confine our imaginations.

Recent changes in government policy, as stated in the White Paper *Realising our Potential*, should not hold much threat for our subject in which there has been a continuous and mutually profitable dialogue between users and researchers. We must not be self-satisfied and aim only at **realising** rewards from known science but must seek to **develop** potential. Exploration, discovery and risk-taking must not be discouraged: our subject needs the vigour of youthful curiosity.

As fresh water becomes a more expensive commodity, the present partial understanding of the science must be improved and refined. In the early days of IH, studies of physical and chemical processes were thought by some to be long shots; pressures for more immediate but fudged results had to be resisted. It is to be hoped that our political masters appreciate that the zigzag path, the blind alleys and the wild hypotheses are the inevitable but indispensable characteristics of a healthy science.

Recent IAHS Publications

The proceedings of six symposia held in Yokohama in July 1993 have been published by the IAHS Press.

Exchange Processes at the Land Surface for a range of Space and Time Scales (IAHS Publ. No. 212, eds Bolle, H.-J., Feddes, R.A. & Kalma, J.D.) brings together aspects of large global change programmes and process studies of water transport at the atmosphere-vegetation-soil interface.

Extreme Hydrological Events: Precipitation, Floods and Droughts (No. 213, eds Kundzewicz, Z.W., Rosbjerg, D., Simonovic, S.P. & Takeuchi, K.) includes statistical analysis, risk management and operational hydrology.

The papers in *Macroscale Modelling of the Hydrosphere* (No. 214, ed. Wilkinson, W.B.) form stepping stones towards the integration of atmospheric and hydrological models at the macroscale.

Tracers in Hydrology (No. 215, eds Peters, N.E., Walling, D.E. *et al.*) ranges from sources of atmospheric deposition to residence times in groundwater.

Hydrology of Warm Humid Regions (ed. Gladwell, J.S.) includes 45 papers on hydrology in the tropics, including human influences and the special problems of islands.

Sediment Problems: Strategies for Monitoring, Prediction and Control (No. 217, eds Hadley, R.F. & Mizuyama, T.) covers problems in arid, semi-arid and humid regions in 31 papers.

The prices range from $50 to $80(US) and volumes may be obtained from IAHS Press (contact Penny Kisby, Tel. 0491 838800, Fax 0491 832256).

A new FRIEND report

The Institute of Hydrology has recently published the report of the FRIEND project: *Flow Regimes from International Experimental and Network Data.*

Edited by Alan Gustard, this is the result of four years work by a team of scientists from 17 European countries working under the UNESCO IHP-IV programme to apply methods of analysis using regional data sets.

The three volumes are *Hydrological studies, Hydrological data* and *Inventory of streamflow generation studies* and may be ordered (price £50 for the set) from the Librarian, Institute of Hydrology, Wallingford, Oxon OX10 8BB.

FORTHCOMING EVENTS

Meetings

International conference on GROUNDWATER Drought, Pollution & Management Brighton 1-3 February 1994

This event concentrates on worldwide concern about long-term sustainability of groundwater resources, it is organised by HR Wallingford and co-sponsored by the ODA, the NRA, IAHR, the European Institute for Water and others.

Dry climate problems, salinity, pollution and nitrate problems, surface-groundwater interactions, UK drought management and artificial recharge will all be covered and there will be a half-day technical visit to Hardham water supply works. The conference fee is £458.25 (£235 for academics and research students).

For further information contact Hazel Dandridge, HR Wallingford Ltd, Wallingford, OX10 8BA (Tel: 0491 835381, Fax: 0491 832233)

2nd International Conference on RIVER FLOOD HYDRAULICS York 22-25 March 1994

Following the 1990 conference on this theme, this conference aims to link current experimental and analytical research to the needs of engineering practice and thus to advance the art of river engineering.

Co-sponsored by IAHR, the ODA and the Northumbria and Yorkshire Region of the NRA, the conference organiser is Jacqueline Watts, HR Wallingford Ltd (*address above*).

Copy Deadline for Issue No. 41 8th January 1994

Diary

9 December 1993
BHS Southern Section
"Routes to chartered status"
Venue: Civil Eng. Dept, Imperial College
Time: 5.30 p.m. (tea at 5 p.m.)
Contact: Howard Wheater, Dept. of Civil Engineering, Imperial College, London SW7 2BU (*Tel: 071 589 5111 ext 4736/4720. Fax: 071 823 8525*)

15th December 1993
BHS National Meeting
"Areal Rainfall Estimation"
Venue: University of Salford
Time: 10.00 to 16.30
Cost: £7.50 (members), £10 (others)
Registration by 8th December to Louise Picton at the ICE, *address below*

13th January 1994
Scottish Hydrological Group / Scottish Hydraulics Study Group
"Hazard risk assessment"
Venue: Lecture theatre B4, Cottrell Building, University of Stirling
Time: 6.30 p.m. (tea at 6 p.m.)
Contact: Dr D J Gilvear, Dept Environ. Science, University of Stirling, FK9 4LA (*Tel: 0786 467845; Fax 0786 467843*)

13th January 1994
BHS South West Section / Welsh Hydrological Group / RGS Western Region
"GIS and Hydrology"
Venue: Cardiff
Contact: Dr Gary Higgs (*Tel.: 0222 874000 ext 5272*)

19 January 1994
BHS Southern Section
"Floods and recharge management in arid areas" Prof H S Wheater & T J Jolley (I.C.), Dr D Peach (Travers Morgan)
Venue: Civil Eng. Dept, Imperial College
Time: 5.30 p.m. (tea at 5 p.m.)
Contact: Howard Wheater, *address above*

31st January 1994
British Dam Society
"Flood Probability: Recent Advances"
Dr Mike Lowing, Prof Ian Cluckie & Prof Chris Collier
Venue: ICE, 1-7 Great George St, London
Time: evening
Contact: ICE (*Tel.: 071 839 9807*)

16th January 1994
BHS/Welsh Hydrological Group
"Evolution of a National Water Resources Strategy"
Venue: NRA, St Mellons, Cardiff
Contact: Linda Aucott, NRA Wessex (*Tel: 0278 457333, Fax: 0278 662153*)

23rd February 1994
BHS Pennines Section
"Solute Transport"
Venue: Warrington
Contact: Elizabeth Kear, NRA North West, PO Box 12, Knutsford Road, Warrington, Cheshire (*Tel.: 0925 53999*)

23rd February 1994
Int. Commission on Irrigation & Drainage
"Irrigation & Drainage Development in Africa" — half-day meeting
Venue: ICE, 1-7 Great George St, London
Contact: ICE (*Tel.: 071 839 9807*)

2nd March 1994
BHS Southern Section
"New developments in surface and groundwater resource management: a Thames Water perspective"
Venue: Civil Eng. Dept, Imperial College
Time: 5.30 p.m. (tea at 5 p.m.)
Contact: Howard Wheater, *address above*

15th March 1994
Scottish Hydrological Group
"Sediment transport & river maintenance" — Dr David Sear, University of Newcastle upon Tyne
Venue: Wellcome Room, Royal Society of Edinburgh, 22-24 George Street
Time: 6.30 p.m. (tea at 6 p.m.)
Contact: Dr D J Gilvear, *address above*

17th March 1994
BHS National Meeting
"Flow Naturalisation"
Venue: ICE, 1-7 Great George St, London
Contact: Dr Alan Gustard, Institute of Hydrology (*Tel: 0491 838800*)

29th-31st March 1994
4th BHS Postgraduate Symposium
Venue: University of Birmingham
Contact: Paul Webster, Dept Civil Eng., University of Birmingham, B15 2TT. (*Tel: 021 414 5055, Fax: 021 414 3675*)

25th-29th April 1994
EGS XIX General Assembly
Venue: Grenoble, France
Contact: Prof P E O'Connell, University of Newcastle upon Tyne (*Tel: 091 222 6405, Fax: 091 222 6669*)

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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