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Hydrological uses of weather radar

BHS National Meeting
ICE, London
9th January 1995

BHS organised this meeting on behalf of the *Inter-Agency Research Committee on the Hydrological Use of Weather Radar* and in association with *IWEM*, the *ICE Water Board* and the *Royal Meteorological Society*. It took the form of a Technical Seminar to update the hydrological community on recent developments in weather radar and its hydrological applications and as such was primarily directed at end-users of weather radar data within the Water Industry. The presentations, providing briefings on current applications, future directions and state-of-the-art research, are published as *BHS Occasional Paper No. 5*.

The first session was chaired by **Dr Peter Walsh** *(Chairman, Inter-Agency Research Committee on the Hydrological Use of Weather Radar)*. In his opening address, Dr Walsh described the work of the Inter-Agency Committee and introduced the day's meeting. The five papers in the first session each covered a different aspect of the current state of the art of radar hydrometeorology.

In the first paper, *Rainfall — analysis and short-range prediction*, **Brian Golding** (Meteorological Office), discussed the information gap that exists between detailed knowledge of the present and immediate future rain distribution (as produced by nowcasting techniques) and the more general longer-term forecasts derived from predictions of the atmospheric state. The Met. Office Nimrod project aims to bridge this gap by using radar, satellite data and synoptic data in conjunction with a numerical weather prediction (NWP) model to provide an improved estimate of core atmospheric guidance variables for input to nowcasting algorithms. The fully automated system incorporates data processing, merging (e.g. satellite and NWP model data are used to correct for bright band and range-related errors in the radar data) and forecasting components, and is expected to be available from mid-1995.

In the presentation *Vertically pointing and urban radars*, **Dr Kevin Tilford** (University of Salford) described two facets of research being conducted by the Water Resources Research Group (WRRG) at the University of Salford.

Firstly he described the use of data from three Vertically Pointing Radars to support the development of an algorithm for automatic bright band identification and correction, and investigations into the spatial variability of vertical reflectivity profiles. Preliminary results demonstrated that the spatial variability of the vertical reflectivity profile (VRP) over relatively small areas (e.g. <200 km^2) was generally such that a correction procedure based on data from one VPR could be used for correction.

He then described a new low-power, low-cost C-band weather radar system, MARS (Multiple Attribute Radar System) developed in conjunction with the McGill Radar Weather Observatory, Montreal. The system has high spatial and temporal resolution (250 m and 2 minutes) and is mainly intended for use in urban hydrology.

The ultimate objective is to produce a turnkey system for the hydrological and meteorological monitoring and modelling of large urban drainage systems (such as in Manchester, Leeds, Liverpool, Sheffield). Kevin ended by demonstrating how the WRRG plan to incorporate the VPR correction procedure into the real-time software for the MARS radar.

Martin Lord (Lancaster University) presented *Adaptive Radar Calibration using raingauge data*, a new method for real-time raingauge calibration of scanning weather radars. The system incorporates a comprehensive range of corrections, based either on image processing (including corrections for beam occultation, ground clutter, bright band, long range and beam infilling correction) or on adaptive statistical estimation algorithms.

The method has been developed for the Meteorological Office radar at Hameldon Hill, but is broadly portable to any of the network radars. Whilst using the same calibration raingauge data as the real-time correction scheme used by the Met. Office, the Adaptive Radar Calibration (ARC) system produces more accurate estimates of surface rainfall intensity. Comparative evaluation of both systems is performed using data from a network

of independent tipping-bucket raingauges.

In his presentation on *Physically-based techniques of estimating surface precipitation rate from radar data*, **Malcolm Kitchen** (Meteorological Office) stated the main problem in estimating the surface precipitation rate from radar data, which stems from the radar beam being some distance above the ground. Large variations in the vertical profile of reflectivity are observed, which result in particular from changes in the height and intensity of the bright band and low-level orographic growth, changes in the depth of precipitation, and the rate of growth of reflectivity above the freezing level.

The variations occur over a wide range of spatial and temporal scales, down to the scale of individual radar pixels. Despite this complexity the author argued that it is worthwhile making use of the limited knowledge of the reflectivity profile in a physically-based correction process, since if these larger errors of meteorological origin could be reduced, then raingauge adjustment is likely to be more successful.

In the final paper of the morning, **Dr Paul Hardaker** (Metstar Consultants, Met. Office) introduced *The GANDOLF system: A look to the future for operational flood forecasting using satellite and radar measurements*. The location and timing of the occurrence of deep convection and thunderstorms are of primary importance for flood forecasting, since small spatial and temporal errors in forecasts may result in widely different actions being taken by duty flood officers. Paul said that improvements in nowcasts of such events are very difficult to achieve.

Nevertheless, the availability in real-time of high spatial and temporal resolution radar imagery, linked to half-hourly or more frequent satellite imagery and NWP model output, offers the possibility of developing procedures giving some prospect of highly site-specific forecasts. Paul outlined a system which adopts a novel object-oriented approach to making such forecasts of thunderstorm weather and demonstrated the improvements which could result. He finished by considering how polarisation and Doppler radar measurements might improve future forecast systems such as GANDOLF.

Second session

The second session, focussing on rainfall and river flow modelling and operational flood warning systems, was chaired by **Dr Richard Bailey** (*President of the Chartered Institution of Water and Environmental Management*).

To start the session, **Chris Haggett** (NRA Thames Region) described *Operational fluvial flood forecasting and warning in the Thames catchment*. He began by describing the Thames region, the extent of the flooding problem (90 000 properties liable to flooding in the Thames catchment, and potential flood damage of £90 million in Greater London alone) and the need for reliable, accurate and timely flood warnings. In an overview of recent developments in the flood forecasting and warning function in the Thames Region, he described the components of the warning system, emphasising the importance of developing an integrated approach to system design to achieve effective reduction in flood damage.

Chris considered that technological advancement was likely to increase the reliability and accuracy of flood warning systems, in particular the need for improved clutter reduction and bright band correction, improved precipitation forecasting, and distributed flow models.

Under the title *Operational flood forecasting in the Wessex Region*, **Linda Aucott** (NRA Wessex Region) described a real-time flood forecasting system called WRIP (Weather Radar Information Processor) which integrates data from raingauges, flow stations, weather radar (5 km regional network) and other sources and generates the inputs necessary for the calibration and operation of the chosen hydrological models.

At present these are Physically Realisable Transfer Function (PRTF) models which are numerically efficient, able to cope with the fast response of the flow data to the catchment rainfall-runoff process. The PRTF model parameters can be updated in real-time through the adjustment of impulse response shape, volume and timing parameters. A number of future rainfall scenarios can be used as inputs to the flow models, such as extrapolated radar rainfall forecasts generated internally by the WRIP system for lead times of up to six hours or user defined inputs. FRONTIERS forecasts will also be incorporated in the near future. The system has been implemented successfully in the Wessex region of the NRA for flood forecasting for more than four years and is now operational in the North West Region.

In *A comparison of the use of radar and rain gauge data in flow forecasting of the River Ribble, Lancashire* **Prof. Keith Beven** (University of Lancaster) described how transfer function models have been used for flow estimation of the River Ribble using distributed radar and raingauge rainfall inputs. Two forecast model plans have been developed according to the locations of the flow gauges and the division into sub-catchments. The first plan involves all the models developed for each sub-catchment to estimate downstream flow. The second plan consists of fewer sub-models with some sub-catchments merged to provide a lumped model for downstream flow estimation. Although the first explains the flow data well in off-line analysis, the second plan provides better downstream flow estimation when used on-line, suggesting that good downstream flow estimation can be achieved with only a few good quality input signals. The second plan has been further tested with radar rainfall estimates and telemetry raingauge records. The results suggest that the radar rainfall estimate has a clear advantage in flow forecasting terms, at least for the winter test storm periods used.

In his wide-ranging presentation on *Rainfall and Flow Forecasting using weather radar*, **Bob Moore** (Institute of Hydrology) described developments in the short-term forecasting of rainfall and flow using weather radars, with special regard to their use for flood warning. The methods of radar rainfall forecasting range from simple field advection and feature tracking approaches through numerical weather prediction models to simple cloud models incorporating the assimilation of weather radar, satellite and weather station observations.

The review of the use of radar rainfall forecasts in flow forecasting focused on the results of a recent comprehensive assessment of catchments in the Thames basin. Tailoring catchment runoff models to make better use of weather radar data has led to the development of grid models whose parameterisations are supported by digital terrain models. An assessment of this distributed approach to flood forecasting was presented, based on results from the new IH Grid Model.

Bob concluded by speculating on the way forward for rainfall and flow forecasting: the potential power of conceptual rainfall models (as opposed to complex, physics-based models), the need for real-time access to atmospheric data — and wind data in particular — and the need for an integrated approach to rainfall measurement and forecasting with a focus on overcoming errors arising from the bright band and orographic growth of rainfall.

The final session, focussing on applications of radar rainfall data, **was chaired by Professor Mike Hamlin** (*President-elect, British Hydrological Society*).

Graham Squibbs (North West Water Ltd) presented *The use of weather radar in the Manchester trunk sewers hydraulic strategy*. He described how radar rainfall data had been used as input into hydraulic models of the urban drainage system (UDS) network model for the Davyhulme Wastewater Treatment Works catchment in Manchester. This is the largest in the north-west, serving a population of 675 000 in a catchment area of 195 km^2. The catchment has approximately 285 combined sewer overflows which spill into nearby watercourses when sewer capacity is exceeded. Radar data were

used to help assess the impact of spatially-variable rainfall over the catchment on the UDS hydraulic models. The general conclusions were that radar rainfall measurements could be applied successfully as long as the data were calibrated with raingauges beforehand. However, the requirement to use spatial rainfall data for the design of such systems remained unproven. The conclusion was that spatial radar data were likely to be of most use for the real-time control of UDSs.

Robert Armstrong (Montgomery Watson Ltd) presented a second UDS case study in the *Beckton/Crossness Case Study*. He described how computer models of the sewerage systems draining to the catchments of Beckton and Crossness Sewage Treatment Works in London were being built. Since both catchment areas are large (combined area 558 km^2) it is assumed that the spatial variation of rainfall is taken into account (by using Chenies radar data) when verifying the models and using them for future analysis of system performance. The study demonstrated the potential usefulness of radar rainfall data in the analysis of large UDSs, but also highlighted the need for reliable data with high accuracy.

Professor Chris Collier (METSTAR Consultants, Meteorological Office) presented *Estimating probable maximum precipitation using a storm model*. He outlined an approach to estimating Probable Maximum Precipitation (PMP) using a simple, totally objective storm model of convective systems. PMP hyetographs were compared with observations for severe events, and the variation of Storm Model PMP with storm duration was compared with PMP values derived using the *Flood Studies Report* (FSR) approach. The Storm Model generated PMP values very similar to the FSR for storm durations less than 11 hours, but for durations between 11 and probably 24 hours the FSR PMP values were exceeded. It was suggested that longer duration events may be associated with Mesoscale Convective Systems (MCSs) which have only been recognised in the UK since the FSR was published.

In the final presentation of the day, **Barney Austin** (University of Salford, now at the Institute of Hydrology) discussed *Using radar data and storm models to assist in the estimation of the probable maximum flood*. As background, he stated that reservoir spillways are designed to pass extreme flood events without significant damage. For Category A dams in the UK (whereby a breach will endanger lives in a community), designs are based on the Probable Maximum Flood (PMF) arising from the critical duration Probable Maximum Precipitation (PMP). This may occur in the winter, coupled with snowmelt, or in the summer when more heat for convection is available.

The results and implications of an analysis of 20 extreme rainfall events occurring in the UK in the past 15 years and observed by radar were discussed. Storm efficiencies have been determined in a Lagrangian frame of reference for these events and used as input into a storm model to determine the corresponding PMP. The results showed that while the peak rainfall rates are somewhat less with the storm model than suggested by the NERC FSR (current UK guidelines), the overall volume of rainfall is slightly greater resulting in differences in the maximum flood storage requirement of the reservoir.

Discussions

The discussions at the end of each session were vigorous and wide ranging. A focal point was the quality of the radar data, the magnitude of the errors that can (and do) occur, and the deleterious effect these can have on 'end-point uses' of the data, e.g. flow modelling. In some situations the errors precluded the use of the data quantitatively. The nature of the errors had been covered within the presentations and further explanations were given in terms of using the wrong Z-R relationship (e.g. during hail), discontinuities between beams in forming the plan position indicators and problems in the real-time calibration of the data. **Dr Walsh** suggested that only by hosting such debates between data users and providers would the outstanding problems be satisfactorily addressed. The new technological developments described were regarded as being particularly exciting, many heralding a new era in radar hydrometeorology to follow the recent period of consolidation. Perhaps the key development will be in the development of integrated systems that combine data from disparate sources and best utilise the information of each, to provide better measurements and forecasts of rainfall.

Professor Mike Hamlin closed the meeting and thanked the speakers and all those who contributed to the discussions for a very interesting and thought-provoking day.

The proceedings of the meeting, edited by Dr Kevin Tilford, with a preface by Dr Peter Walsh, have been published as *BHS Occasional Paper No. 5*. It has 165 pages, ten of them in colour, and can be obtained from **Dr Angela Gurnell**, School of Geography, University of Birmingham, Birmingham B15 2TT, at a cost of £10 (BHS members) or £15 (non-members), plus £1.50 postage and packing.

Kevin Tilford & Richard Griffith
University of Salford

President's Piece

In the last edition of *Circulation*, I mentioned that the Society's R&D Strategy had now been published. Some 200 copies have been sent to people in a position to influence hydrological research in the UK and overseas.

The response has been very positive. Several organisations have already taken the trouble to write to indicate that the document was most timely and would help to formulate their thinking on hydrological research. Notable amongst these were NERC and EPSRC, who are currently reviewing their research programmes. Supportive letters have also been received from the MoD and the NRA. **Sir Charles Pereira** was extremely positive and suggested that it might be worth holding a seminar, in conjunction with the Royal Society, to discuss the main advances in research.

In April the BHS Main Committee considered proposals from the Millennium Project Working Party, which had met to consider ideas put forward by **Max Beran** to create "A Thousand Years of Hydrological Data", involving reconstruction of hydrological records and producing a multi-media CD-ROM. The group contained experts in palaeohydrology, climatology, dendrochronology and geomorphology, as well as mainstream hydrologists. The Main Committee accepted the working party's view that the proposal was technically sound. The next stage is to estimate the costs of the project and the potential for sponsorship and other funding, prior to deciding whether to go ahead with what, on the face of it, seems a very exciting initiative.

I was delighted to hear that IWEM have finally achieved their ambition to become a Chartered Institution. This clearly now opens up a route to Chartered status for those hydrologists who do not wish to pursue the Royal Met Soc or ICE routes. The relationship between BHS and CIWEM remains good, and regular meetings at Presidential level are to continue, albeit less frequently than in recent months.

Working relationships are to be consolidated via the BHS President's involvement in the CIWEM Water Resources Panel and CIWEM providing an observer to BHS Main Committee

meetings. It has been agreed that it would be helpful to have a *Memorandum of Understanding* between the two organisations. Whilst this does not have any legal status, it is intended that the document will set down a mutual understanding of the nature of the relationship between the two independent organisations. Once the wording has been finalised, the Memorandum of Understanding will be published in *Circulation*. Amongst other things, this document will recognise the value of the BHS and CIWEM working together on a range of topics, such as joint meetings, publications and Education and Training.

As we start to look towards the end of another BHS year, I would like to remind you that the time is upon us when we seek nominations to the Main Committee. A flyer went out in March, but there is still time for those energetic members who want to help shape the face of the Society to get their nomination forms in.

Also thinking ahead, plans for the Heriot-Watt Symposium in September are now well advanced. **Paul Jowitt** and his local organising committee have produced a full and varied programme of technical and social activities. We are looking forward to another successful gathering. In order to make the organising committee's job easier, early booking would be appreciated.

Susan Walker

Obituary: Edmund (Tim) Hambly

It is with sadness that I have to announce that **Dr Edmund Hambly**, President of the Institution of Civil Engineers, died on *28th March*, having been suddenly taken ill during the previous weekend. At 52, he was one of the youngest Presidents ever to lead the Institution.

Edmund was a friend to BHS, because he strongly supported the role of Associated Societies within ICE, and he was particularly keen to make sure that those professionals outside mainstream Civil Engineering were not disadvantaged when they were seeking Chartered status. Had he completed his term of office (which was due to end in November), I believe that he would have ensured that the recent policy changes regarding Chartered status (reported in previous issues of *Circulation*) were followed through in practice, with a sense of urgency.

In my meetings with Edmund, he always showed great vitality and energy, which I am sure would have guaranteed success in his initiatives as a moderniser within the Institution.

Prof Tony Ridley, who would have succeeded Edmund in November, has agreed to take on the Presidential role with immediate effect. Tony specialises in transport engineering and holds a Chair in Civil Engineering at Imperial College. Bearing in mind the similarity in issues within the Institution affecting transport professionals and hydrologists, I am sure Tony will be equally supportive of the needs of hydrologists within ICE.

Susan Walker

Letters to *Circulation*

Flood marks

From R J Sargent, Chief Hydrologist, Forth River Purification Board:

Dear Sir,

The article by David Archer (*Circulation 45*) indicates many reasons to doubt flood marks. Inaddition to 'wrong month' and 'wrong year', I could add 'wrong building': in Haddington on the East Lothian River Tyne a plaque marks the height of the 1775 flood. Closer inspection reveals that the plaque is on a building dated 1874!

Perhaps the plaque was carefully repositioned on the new building, but a nearby bridge over the river has a similarly reused stone block incorporating an Ordnance Survey benchmark — pointing sideways!

Yours faithfully,

Bob Sargent

A hydrological mystery

From R E Manley, Consultant in Engineering Hydrology, 78 Huntingdon Road, Cambridge CB3 OHH:

Dear Readers,

Forget about the Bermuda Triangle, forget about crop circles, get your grey matter working on a real puzzle — a hydrological one at that!

For ten or fifteen years I have heard reports on diurnal variations in water level in rivers and streams. This manifests itself as an increase in levels during the night and a drop during the day but would only be observable at periods of low flow when there was little other variation in levels. The initial reaction of people who observed this was that it was due to variations in discharge from sewage works upstream. In some cases there were no sewage works but I was able to convince myself that perhaps there were unrecorded discharges or abstractions to account for it, until ....

I then heard of a case from Oman. Certainly there was no sewage flow there. At this site levels were measured by a float, so I did a quick calculation based on the length of cable and the thermal expansion of the metal, and satisfied myself that I had found an explanation, until ....

Recently I was talking to a hydrologist who had worked in Malawi who had observed exactly the same phenomenon. At this site there was no sewage flow and levels were recorded by an observer using level boards. This hydrologist had tried to find an explanation and could not.

So this is the problem. Have any of you proof that it exists? And, what is more important, if it does exist what causes it?

Yours sincerely,

Ron Manley

Sad state of hydrometry

From Mr J O Robertson, Javea, Spain:

Dear Mr Griffin,

As one who in the past sweated and struggled to help establish and maintain gaugung stations in Kenya, I was saddened to read **James Dent**'s timely article (*The parlous state of hydrometry overseas, Circulation 44*).

In colonial times, hydrologists and water engineers in the Public Works Offices regarded maintenance as just as important as getting the money and installing equipment, even if at times it was only a floodstick.

James Dent's article merely confirms what many of us already know, but let us hope that others in influential positions may read it* and act in some way to improve on a sad state of affairs, often caused by handing over a valuable asset, without pain or suffering being experienced by the reciever.

In 1980 I found the same thing happening in an East African country [*name supplied on request*]. I went to all the stations and found many irregularities. The main plates on a whole set of step gauges on a lake bed had corroded away, but we still received readings! The engineer in charge was loth to leave his office to go on a tour of inspection, for fear that another incumbent would be sitting in his chair when he returned! And so it went, and so it goes and will go on.

As a retired water resources engineer / hydrologist, I enjoy reading *Circulation*. Keep up the good work!

Yours sincerely,

James O. Robertson

**P.S.* May I suggest that a few copies of *Circulation* be dropped on a few boardroom tables of certain companies! *JR*

Royal Charter for IWEM — and understanding with BHS

IWEM, the Institution of Water and Environmental Management, has been awarded the supreme accolade of a Royal Charter, after 100 years of professionalism and service in the field of water and environmental management. CIWEM joins the constellation of chartered bodies which also includes the Institution of Civil Engineers.

As highlighted in the *President's Piece* (p. 3), BHS members now have a clear route to chartered status through CIWEM, as well as the ICE and the Royal Meteorological Society options.

BHS and CIWEM are preparing a *Memorandum of Understanding*. This will not bind the two organisations in any way, but will demonstrate mutual interest and a cordial professional partnership between the two bodies.

Flood prediction and flood warning

BHS Pennines Section University of Salford 22nd February 1995.

***Prof. Ian Cluckie* (University of Salford) welcomed 75 members to an informative afternoon meeting on flood prediction and flood warning, chaired by *Prof. Keith Beven* (University of Lancaster).**

Mark Tinnion (NRA Northumbria and Yorkshire) presented the first paper, detailing the use of information systems to support statutory flood prediction and warning.

The system, developed by Logica UK, has two roles. First it must control the Regional Telemetry System (RTS) of more than 200 outstations, grouped into geographically layered subcatchments, which provide a structure for the graphical user interface. The system is capable of polling the stations and operating some equipment remotely. It also can incorporate daily rainfall forecasts from the Met. Office and has the potential to use radar data, although this is not used in generating flow or rainfall forecasts at the moment. The RTS thus gives the duty officer access, by workstation and remote PC, to river flow, level and quality information as well as rainfall and climate data. The system has helped the NRA to maintain their records of this winter's floods and has improved efficiency by enabling up to ten outstations to be polled every 90 seconds.

The second role is that of flood forecasting. Thus the system uses the above data to invoke models developed and calibrated by the Institute of Hydrology when specified alarm levels are reached. In estuarine areas tidal forecasts are also included, based on astronomical data and surge predictions from the Met. Office. These models can provide forecasts at over 100 locations for periods from hours to days ahead although flood prediction is restricted to a maximum lead time of 24 hours. This is sufficient to allow defence schemes to be activated and flood warnings to be disseminated.

The discussion that followed centred on the robustness of the system to spurious data and the need for backup outstations and manual editing of the data files. It was noted that a variety of rainfall scenarios may be input to the flow forecasting models. The success of issuing warnings was also assessed by distributing questionnaires to those members of the public affected by the flooding.

The second presentation by **Dr Matthew Lees** (Lancaster University) considered the Dumfries flood warning system developed by CRES (Centre for Research on Environmental Systems and Statistics) for the Solway River Purification Board. Its objective was to produce forecasts five hours ahead on the River Nith at Dumfries via a fully automated system using information from existing gauging stations. The forecasting model incorporates level-level and rainfall-level transfer function models together with an adaptive gain parameter which is estimated recursively in real time. The latter allows changes in the gain of the system to be tracked which in turn can result in improved forecasts.

On receiving an alarm from an outstation the system polls all stations and forecasts a level for Dumfries. If a flood is predicted the police are issued with a yellow, amber or red alert. Although the use of level data can introduce non-linearities to the modelling structure, the forecasting system, which has now been operational for four years, has proved successful. This is exemplified by the December floods of 1994 in south-west Scotland when 60 to 70 mm of rain fell during a 2-day period and the models produced accurate 5-hour-ahead forecasts of the resulting floods.

Points made in the discussion included the need to recalibrate the models periodically. It was suggested that the use of level data works because there is no distinct non-linearity threshold at bank-full discharge and also that the rainfall-flow elements of the model are not very significant in the results of the overall forecasting scheme.

Fan Cheong Tsang (Lancaster University) then gave a paper entitled flow forecasting for the River Ribble using rain gauge and radar data. The procedure described involved the provision of forecasts three hours ahead at three locations by combining rainfall-flow and flow-flow time series transfer function models together with state updating parameters. Two forecasting strategies were compared and it was found that the second — which uses fewer subcatchments — provided better on-line forecasts for the period examined.

This set of models was then used in a comparison of raingauge and radar inputs. The former were transformed using Thiessen Polygons to provide an areal input of averaged rainfall within subcatchments. The latter were divided into two sets, those as calibrated by the Met. Office and those which were transformed pixel-by-pixel using a raingauge calibration surface in order to remove anomalous data. Despite the fact that the transfer function models were calibrated with raingauge data, the Lancaster adjusted radar data gave the best forecasts during the winter test periods.

The discussion considered the use of raingauge based correction procedures and the danger of raingauge networks missing small convective cells.

The final paper of the afternoon was presented by **Dr Han Dawei** (University of Salford). It described a real-time flood forecasting system called WRIP (Weather Radar Information Processor) developed for the NRA South Western and North West regions. A continuous programme of improvements and additions is being undertaken in concert with the water industry and

there is a close involvement with various European partners through the auspices of the Commission of the European Communities.

The system integrates data from raingauges, flow stations, weather radar and other sources and generates the inputs necessary for the calibration and operation of the chosen hydrological models. At present these are Physically Realisable Transfer Function (PRTF) models which are numerically efficient, able to cope with the fast response of the flow data to the catchment rainfall-runoff process. Once the source of forecast error has been identified, the PRTF model parameters can be updated robustly in real-time through the adjustment of impulse response shape, volume and timing parameters. It is envisaged that an expert system will be incorporated to store knowledge about the relationship between storm characteristics, available in advance from radar data and these adjustment factors.

A number of future rainfall scenarios may be used as inputs to the flow forecasts, such as extrapolated radar rainfall forecasts generated internally by the WRIP system for lead times of up to six hours, or user-defined inputs. FRONTIERS forecasts will also be incorporated in the near future. This system has been implemented successfully for flood forecasting in the NRA Wessex Region for more than four years and is now operational in the North West Region.

Prof. Keith Beven closed this very informative meeting with a vote of thanks to all the speakers.

Richard Griffith
Salford

Hydrological research at West Midlands universities

BHS Midlands Section Meeting
NRA Severn Trent Region, Solihull
8th March 1995

The purpose of the meeting was to give an overview of the broad spectrum of current and recent hydrological research in the West Midlands universities, and to spawn future collaborations and discussions between parties with similar interests. Forty people attended, including representatives from eight of the Midlands research institutions, while speakers from Coventry, Wolverhampton, Aston and Birmingham Universities took on the onerous task of introducing hydrological research across their entire respective campuses.

The speakers were keen to stress the enormous diversity of hydro-research and the inter-school cooperation, with research spanning the schools of Geography, Earth Sciences, Environmental Sciences, Biological Sciences, Chemistry, Civil Engineering and Electronic Engineering.

With only a short time available to cover a potentially vast array of topics, the speakers took different approaches — some preferring to restrict themselves to more detailed descriptions of only a few projects. The general areas of research and specific topics mentioned are summarised in Table 1. Obviously this table reflects the chosen approach of the speakers and is not an exhaustive list of all hydrological research taking place at the four universities. The summary should serve to advertise areas of interest and thereby encourage readers working in related fields to communicate with the universities concerned and share their ideas and results.

Coventry University

After a brief introduction and welcome from chairman **Richard Cross** (NRA Severn Trent), **Dr John Dearing** (Coventry University) opened the proceedings. He chose to give a cross-campus view and briefly described eight projects.

The mechanical and chemical effects of ultrasound on water treatment are being investigated by the sonochemistry group. In laboratory tests it has been used to degrade solvents, polymers and pesticides, to enhance metal ion removal, and to break up bacterial clumps.

The *cryptosporidium* group are studying the movement of this diarrhoea-causing protozoan from the faeces of mammals to watercourses. Wild fieldmice have been found to be significant transporters.

The civil engineers have been working on an improved block pavement structure design for use on car parks and other areas prone to pollution spillages. The multi-layered physical structure of the new pavement can reduce peak runoffs and is able to trap pollutants and reduce the BOD and suspended solids of the outflow.

An original feature of the new pavement is a subsurface membrane, and the biologists are now collaborating with the engineers to impregnate this membrane with bacteria capable of metabolizing the carbon in oil and diesel spills.

Wolverhampton university

Dr David Mitchell (Wolverhampton University) opted to concentrate on hydrological-related studies in the Environmental Sciences Department, and he illustrated clearly their soil erosion fieldwork with slides from the UK, China and Spain. The Department maintains a series of sloping erosion plots equipped with interflow pits and lysimeters where hydrometric data are frequently measured and analysed.

Much effort has been directed towards methods of preventing wind-blown sand-dune erosion in China. One successful method of stabilising the dunes is to lay straw across the plot in a checkerboard pattern to reduce the aerodynamics of the dunes. Indigenous species can be planted between the straw grids in such a way that, by the time the straw has finally rotted away, a more resistant biocrust will have formed on the dune surface, protecting the loose sand beneath from the power of the winds.

Aston University

Dr John Elgy (Aston University) concentrated on hydrological uses of remote sensing and geographical information systems (GIS). Dr Elgy classified three stages of a modelling project: data acquisition, data storage and manipulation, and the modelling itself. He believed that commercial modelling packages (e.g. Wallrus, Spida) were adequate, but that there were difficulties with the initial phases and with the phase linkages.

Remote sensing and GIS can help with these problems, and Dr Elgy used an urban sewer system example to illustrate his point. Satellite images can be helpful for catchment scale hydrology but the pixel size from is often too large for urban drainage modelling purposes. Aerial photographs give very useful and up-to-date information, particularly for urban areas where the construction or demolition of factories or housing estates can have a significant effect on the local hydrology. Remote sensing images or maps can be scanned into GIS systems which can then derive useful information from the image, for example, the proportion of impermeable area.

Paul Webster (University of Birmingham) asked how successfully these automatically derived parameters compared with known ground truth. On the whole they are reasonably successful, but in many cases calibration against a small test area is required. Digital elevation models can successfully determine the position of

Table 1 Hydrological research topics at West Midlands Universities

Research topic	University
Traditional hydrology & hydrogeology:	
Snowmelt energy balance & runoff	Birmingham
Rainfall: frequency analysis, variability, stochastic modelling	Birmingham
Linkage of hydrological & hydrodynamic models	Birmingham
Flood channels: physical models, multi-stage & meandering channels	Birmingham
Floodplain wetlands: monitoring & modelling	Birmingham
Flume studies	Birmingham
Irrigation system losses	Birmingham
River-aquifer interactions under low flows	Birmingham
Groundwater quality: nitrates, saline intrusion, landfill sites	Birmingham
Groundwater modelling: recharge mechanisms, vertical flows, regional models	Birmingham
Sediments:	
Catchment sediment movement budgets using linear modelling	Coventry
Reconstructing historical erosion rates from lake & reservoir deposits	Coventry
Storm caused soil erosion: field studies in UK, China & Spain	Wolverhampton
Wind-blown dune movement: stabilisation methods	Wolverhampton
Sediment transport in estuaries: monitoring & modelling, adsorbed pollutants	Birmingham
Downstream changes in river hydraulics	Birmingham
Biology & ecology:	
Ability of aquatic reeds to soak up heavy metals	Coventry
Cryptosporidium: protozoa movement from mammals to water	Coventry
Benthic indices development	Aston
Minimum acceptable river flows	Birmingham
River margins as indicators of climatic change	Birmingham
Bacteria impregnated membrane in pavements to metabolise carbon in pollutants	Coventry
Remote sensing and geographical information systems:	
Remote sensing to map lake suspended solids	Coventry
Remote sensing to monitor vegetation stress	Aston
GIS to predict nitrate vulnerable zones	Coventry
Remote sensing and GIS uses for data acquisition, storage and manipulation	Aston
Linkages between GIS and commercially available models	Aston
Technological developments:	
Wave energy converters	Coventry
Water powered air turbines for low head power generation	Coventry
Sonochemistry: ultrasound used in water treatment	Coventry
Synthetic pavement structure to filter pollutants & reduce peak run-off	Coventry
Bank erosion: automatic measurement	Birmingham
Other research projects:	
Agricultural land resource appraisals: impacts of climatic change on crop yields; infrastructure investment required to support growing populations	Aston
Benefits of the Meteorological Office to the UK economy	Birmingham
Cost/benefit of enhancements to sewage treatment works	Birmingham
Evaluation and development of external software	Birmingham
Air quality & global atmospheric chemistry	Birmingham
Effects of climatic change	Birmingham
Urban drainage: sewerage design, sewer water quality	Aston

rivers and resulting catchment areas in undulating terrain, but are considerably in error in flat or urban areas, so more traditional methods will always be required.

Dr Elgy is also involved in investigating the ability to link several models and data sources in one GIS, which he illustrated with a groundwater modelling example, calculating the effect of different pumping scenarios on crop yield in a landscape with varying depths of drift cover.

Bogus Zaba (NRA) enquired about the use of remote sensing for landfill monitoring. When aerial photographs are taken using certain wavelengths, lush healthy vegetation appears lighter than vegetation under stress, hence areas suffering from landfill gas poisoning are apparent. In urban areas under drought conditions, lawns which are frequently irrigated stand out from their neighbours, so remote sensing could be used to monitor illegal lawn spraying!

University of Birmingham

The final speaker was **Paul Webster** (University of Birmingham), who managed to compile an extensive list of cross-campus hydrological research topics and areas of interest, which he subdivided into atmospheric, land and subsurface interests, but he also emphasised the integrated catchment management approach taken on some investigations.

He indicated preferences of the different Schools for mechanistic research, monitoring and modelling, or management studies.

Paul described an automatic bank erosion measurement sensor developed by **Dr Damian Lawler** (School of Geography) known as the 'photo electronic erosion pin' or PEEP sensor. **Richard Cross** suggested that the disturbance caused while installing the sensor may itself enhance bank erosion. Field observations using the sensor indicate that bank retreat tends to lag behind peak flow by a few days. **Dr Mitchell** suggested that frost lifting could be partially responsible for the observed bank retreat — it would be useful to measure soil temperature at the same time.

Richard Cross concluded the meeting by thanking all the speakers and hoping areas of common ground could be exploited to mutual benefit. He will be organising a similar meeting early next year to give the East Midlands universities an opportunity to present their research.

Rachel Spence
NRA, Severn Trent Region

Modelling river-aquifer interactions

Joint BHS National Meeting with the Geological Society Burlington House, London 28th March 1995

This joint meeting of the British Hydrological Society and the Hydrogeological Group of the Geological Society was attended by 126 people. This report just provides a brief summary of each paper and some of the issues raised in discussion. Full proceedings of the meeting are published as *BHS Occasional Paper No. 6*, 'Modelling river-aquifer interactions', edited by *P. L. Younger*.

The morning session considered river dominated systems and was chaired by Paul Younger. **Jane Dottridge** (University College London) presented the first paper which considered work done with **A. Alderwish** on the use of MODFLOW to study aquifer recharge due to ephemeral wadi flows. They used available hydrogeological data to construct a model of the aquifer and calibrated the model with well hydrograph responses using measured and estimated floods. The sensitivity analysis indicated that recharge is influenced mainly by flood duration, and the models will be used to predict aquifer recharge over a ten year period.

C. Bradley and **Geoff Petts** (University of Birmingham) then described fieldwork and modelling of bank storage processes in the River Wolf in Devon, discussing the response of the system to a controlled release of water from the Roadford Reservoir upstream. A MODFLOW model was used to try and replicate the hydraulic heads observed in dipwells close to the river. The model was then used to consider what hydrological processes may be active in the system.

The paper illustrated some possibilities of a combined monitoring and modelling approach to the estimation of hydraulic properties of a system. The authors acknowledged that the behaviour of the system close to the river was poorly understood and attributed the constant groundwater heads in this zone to a high transmissivity layer, possibly a palaeochannel or flood plain. **Ken Rushton** (University of Birmingham) queried this and James Bathurst asked about the values of hydraulic conductivity used in the model. C. Bradley explained that these were obtained from tensiometers installed beside the river.

The third paper of this session was presented by **James Bathurst** (University of Newcastle) and **K. R. Cooley** (USDA), describing the application of the Système Hydrologique Européen (SHE) model to snowmelt events in the Reynolds Creek catchment, Idaho, USA. The model was applied first to a small (40.4 ha) subcatchment where the model was able to reproduce near-channel processes. SHE was also used on the full catchment (234 km^2) and although it identifies large-scale processes, those on a smaller scale (for instance near-bank processes) were not represented. This paper presented an interesting contrast between the use of a model on two different spatial scales.

This was followed by **Rob Gray** (W. S. Atkins) discussing modelling of the Malmesbury Catchment in the Cotswolds. The work, in conjunction with the NRA, used the MIKE SHE model to examine the effect of groundwater abstractions on streamflow. A combination of consultations with the general public and modelling was used to identify acceptable low flows for use in catchment planning. The model also examined the assumption that the Inferior and Great Oolite were hydraulically connected, and found — contrary to previous studies — some evidence for this. Rob demonstrated some model simulations during his presentation, an effective illustration of the catchment behaviour. **Sandy Elsworth** (Mid Kent Water) asked whether the new boreholes were causing flow between the Inferior and Great Oolite but this had been checked during the study and found not to be the case at the majority of sites.

James Bathurst asked about the soil bypass mechanism: Rob explained that this was needed to explain the rapid

response to recharge during wet periods.

K. Clark (Intera) presented work undertaken with **D. Oakes** (WRc) and **D. Wilkinson** (Anglian Water) to develop a model to predict the effect of land-use change on nitrate concentrations in the River Gipping. ROSANN, a coupled river and groundwater model, uses readily available hydrogeological and land-use data, and the calibration of the model takes advantage of the fact that water quality data are generally available for more points in a catchment than stream flow data.

ROSANN contains a distributed leaching component and a lumped parameter flow and transport model. The authors found that this relatively simple approach was able to model the system satisfactorily, and that the rapid response of the catchment to rainfall events meant that nitrate concentration depended strongly on the timing of fertiliser application. In reply to a question from **Mike Price,** the limits of soil saturation in the model were described as the soil water saturation capacity and the soil water holding capacity. Responding to a question about the effectiveness of a lumped parameter approach, it was explained that the use of a distributed model would have some disadvantages, for instance the model would become much slower to run.

Beeson Mwaka, Enda O'Connell, C. Nalluri and **P.L. Younger** (University of Newcastle) described work modelling the response of a river bed to changes in flows and the effects that changes in bed sedimentation may have on river-aquifer interactions. The thickness of the sediment layer controls the resistance of the river bed to seepage, and sensitivity analysis indicated that the river baseflow is strongly influenced by changes in sedimentation rates.

The morning session concluded with **Nigel Hepworth** (NRA, Southern Region) discussing an example of high river flows generated by groundwater flooding in a chalk catchment. After widespread flooding in 1994 the NRA decided to develop a model that could be used to predict river flows over a period of a few hours (compared to the longer timescale of most resource models). The approach they used was a recession analysis and storage routing technique that can be run on a Lotus spreadsheet.

At present the model only predicts river flows, and the NRA intend to extend this to a distributed catchment approach. The presentation ended with a request for ideas of suitable catchment models. James Bathurst suggested that the SHE was suitable as a research tool, but over longer timescales than those required by the NRA. Nigel Hepworth was also asked about his confidence in the use of a simple model for a complex system and explained that it had proved adequate for producing the type of results required.

The afternoon session was chaired by **D.I. Russell** and opened with **D. Gamble** presenting work by **M. Futter** and **Y.S. Yoon** (Montgomery Watson). They developed an integrated ground and surface water model (IGSM), a finite element model to be used in catchment management planning, especially in areas where low rainfall and groundwater pumping control low flows in rivers. The paper described different scenarios of river/groundwater coupling and then discussed a case study, using IGSM to create a management plan for the Salinas Valley in California, a region with high agricultural production and 90% of the water supplied from groundwater.

Andrew Hughes asked whether the groundwater and surface water catchments coincided; he was told that the model uses a groundwater basin rather than a surface water catchment.

Ken Rushton and L. M. Tomlinson (University of Birmingham) then described the modelling of interactions between the Sherwood Sandstone aquifer and Nottinghamshire rivers. The sandstone is a major groundwater source with some boreholes located within 1 km of rivers. A model of the aquifer was developed, taking into consideration transmissivity, storage coefficient, recharge, leakage, abstractions greater than 0.1 Ml/day and river-aquifer interactions. This model can then be used to identify areas of the aquifer from which rivers gain water and also to examine the effect of pumping on river levels. Mike Price asked about the characteristics of the river bed: Ken Rushton felt that in this case it did not influence flows into or out of the river.

The next presentation was from **Jan Van Wonderen** (Mott Macdonald), discussing the validity of methods used for modelling river aquifer interactions. He described various strategies applied to both UK and overseas catchments, notably the Dhaka region in Bangladesh and flood modelling in the River Thames. He concluded that the important step for a modeller was the development of a conceptual understanding of river-aquifer interactions. This can then be applied to develop correct modelling concepts, demanding the flexibility to be able to accommodate 'unusual situations' by adapting model code where necessary. This paper generated several questions and comments from the floor. Sandy Elsworth asked about driving mechanisms for flow during Thames floods and was told that the flooding of river banks increased the rate of infiltration. Jan Van Wonderen was also asked about the movement of sediments during floods and changes in bed load behaviour. He explained that water levels are controlled by sluice gates and so any changes are likely to be small.

The next paper, presented by **O. Akande** (Halcrow), described work with **E. E. Wilson** on simulating river aquifer in interactions in a chalk catchment. The groundwater model (SLAY) was modified to consider the properties of chalk aquifers including the simulation of variable transmissivity with depth. The models were developed as aquifer management tools and provided a reasonably accurate method of predicting exchange flows between the aquifer and the river.

After a short break the session continued with a paper by **A.N.B. Charalambous, D. J. E. Buckle, R. Sage** and **P. J. Aldous**. This was presented by Dave Buckle (Hydrogeological Services International), who discussed the contribution of river seepage to borehole yields and the implication for designation of source protection zones.

This study concentrated on the Gatehampton area, Goring-on-Thames, calculating the proportion of river water abstracted in the borehole and finding this higher than in previous studies. The paper also compared the shape and extent of capture zones, as predicted by the models MODPATH and FLOWPATH, concluding that the shape and extent of capture zones is strongly influenced by the choice of model. It was conceded that the flows from the river suggested by the model did not tally with hydrochemical evidence.

A paper by **J. A. Heathcote** and D.I. Russell (Entec) followed, discussing shallow groundwater in the Cardiff bay area and the potential effects of the proposed Cardiff Bay Barrage. The groundwater level is generally within 0.5 m of the ground surface. Some pumping tests were carried out, although much of the area is built on contaminated land with polluted groundwater. The tidal effects are complicated and Fourrier transform methods were used to analyse the results. The aim of the project is to find a method of holding groundwater at pre-barrage levels as this is cheaper than repairing any damage caused by changes in groundwater levels.

The last presentation was from **Mike Carey** (Aspinwall & Co) and **D. S. Chadha** (NRA, York) looking at low flow problems in the River Derwent. This river supplies Scarborough with water and in some parts of the catchment it loses water. A two-layer MODFLOW model was used for the aquifer and the stream routing package used for river-aquifer interactions. This model was designed to be used in catchment management decisions.

The chairman summed up some of the issues raised: discussing the verification of interactions, the influence of grid spacing and numerical methods on results and the importance of vertical gradients.

Judith Stunell
Newcastle upon Tyne

Fifth BHS Postgraduate Symposium

University of Salford
3rd-4th April 1995.

The Fifth BHS Postgraduate Symposium was held at the University of Salford in the first week of April. The Symposium provided an opportunity for postgraduate students (current and recent) to present their work and discuss it within their peer group in an informal and friendly environment. Over 35 postgraduates attended, over half of them making technical presentations. As in previous years, the presentations covered an extremely wide range of topics illustrating to good effect the inter-disciplinary nature of hydrology.

The quality of the student presentations was exceptionally high and congratulations are due to all the presenters. The £50 book token prize for the best overall presentation (as judged by all the student delegates and the Symposium chairman) was awarded to **Darren Crook** (University of Huddersfield, Dept. of Geographical and Environmental Sciences) for his presentation on *'The evolution of water management in ancient Swiss mountain irrigation systems'*.

The final afternoon featured a presentation by **Phil Barton**, Executive Director of the Mersey Basin Trust. His talk on the work of the Mersey Basin Campaign, a 25-year, £4 billion programme to clean-up, regenerate and revitalise the River Mersey, its tributaries and their waterfronts was especially well received and prompted a lively discussion. The presentation was followed by a visit to the Salford Quays. At the Heritage Centre, the delegates enjoyed a slide-show tour through the history of the Manchester Ship Canal and Salford Quays from the late 19th Century to the present day redevelopment. I think everyone was surprised to learn that salmonoid fish have now made a successful return to the Quays, after a break of well over one hundred years.

The abstracts of the presentations and a list of delegates are available from **Dr Kevin Tilford**, University of Salford (no cost), or direct from the bhs-hydrology mailing list — simply send the one-line command 'send bhs-hydrology pg-symp.txt' to **mailbase @mailbase.ac.uk**.

Kevin Tilford
Salford

New Members

We welcome the following members to the Society:

Abrahart, R.J.	Leeds, West Yorkshire
Brocklebank, M.S.	Guildford, Surrey
Creurin, J.D.	LTHE, Grenoble, France
Cummins, D.J.R.	Sir William Halcrow & Partners, Swindon
Davys, M.J.	University of Birmingham
Goody, N.P.	Aberdeen
Griffiths, P.	Sheffield Centre for Ecology & Environmental Management
Krumer, R.A.	Streetly, West Midlands
Lindsay, D.A.	University of Birmingham
Pimentel da Silva, L.	University of Newcastle upon Tyne
Miller, J.B.	Geneva, Switzerland
Montenegro, A.A.	University of Newcastle upon Tyne
Montenegro, S.M.G.L.	University of Newcastle upon Tyne
Mullis, E.A.	NRA Severn Trent Region, Solihull
Mulcahy, M.	Stoke on Trent, Staffordshire
Reynolds, T.I.	Cambridge
Savic, D.	University of Exeter
Wass, P.D.	York LOIS Lab., Dept. of Biology, University of York
Woolgar, M.J.	Epsom, Surrey
Zainal Abidin, M.R.	Aston University, Birmingham

News from Members

Retiring to consult

Dr Peter Walsh has left the NRA, after 29 years managing the rivers in north-west England, in order to undertake consultancy work.

Following a short mission to Dhaka in February, he will be assisting WMO and Danish Hydraulics for 12 months over the next three years in developing and implementing a flood warning dissemination system in Bangladesh.

Secretary's baby

Congratulations to the BHS Secretary, **Louise Picton,** who has had a baby son, Samuel, weighing 3 kg (6 lb 10 oz in cusecs). Mother and baby are both fine.

Treasurer expanding

Rod Hawnt's company, Hydro-Logic Ltd, has moved to larger premises. The new address is Hydro-Logic Ltd, Old Grammar School, Church Street, Bromyard, Herefordshire, HR7 4DP, Tel. 01885 483789, Fax 01885 483792.

Paper award

Congratulations to **Mike Acreman,** who is to receive the CIWEM Younger Members' Paper Award for *Assessing the joint probability of fluvial and tidal floods in the River Roding*, published in *J. IWEM*, Vol. 8, No. 5, October 1994.

Scottish news

Andrew Black, Secretary of the Scottish Hydrological Group, is moving from the Institute of Hydrology, Stirling, to a new post at Dundee University. From *1st August 1995* he may be contacted at the Department of Geography, University of Dundee, DD1 4HN, *Tel. 01382 344433, Fax 01382 344434.*

New PhD

Barney Austin, now in the Institute of Hydrology's Water Resource Systems Section, has been awarded his PhD from the University of Salford. His thesis title was *Probable maximum flooding using quantitative weather radar.*

Newsletters received

BHS receives publications on a reciprocal basis from other hydrological societies, including the *Nieuwsbrief van de Nederlandse Hydrologische Vereniging*, published four to six times a year, and *Current*, the newsletter of the New Zealand Hydrological Society. These and other journals, newsletters and reports received are kept in the Institute of Hydrology library for members to consult, by appointment with the librarian (Tel. 01491 692266).

Publications

Earth Views is published three times a year by the Environment Assessment Programme of the United Nations Environment Programme (UNEP). For a free subscription, please write to Earth Views, Environment Assessment Programme, UNEP, P.O. Box 30552, Nairobi, Kenya. (Fax +254 2 623943 or 623944, Email EAINFO@UNEP.NO, Telex 22068 UNEP KE).

There are two new WMO *Operational Hydrology Reports*: No. 40 is *Land surface processes in large-scale hydrology* by J.D. Kalma and I.R. Calder (price SFr 20); No. 41 is *An overview of selected techniques for analysing surface-water data networks*, by W.O. Thomas (SFr 15). Order from the Secretary General, WMO, PO Box 2300, CH-1211 Geneva 2.

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 (**Paul Younger**, Department of Civil Engineering, Cassie Building, University of Newcastle, Newcastle upon Tyne NE1 7RU, Tel. 0191 222 6000 ext. 7942, Fax 0191 222 6669, Email P.L.Younger@newcastle.ac.uk), 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.

FORTHCOMING EVENTS

Meetings

BHS National Meeting
SCALE PROBLEMS IN HYDROLOGICAL MODELLING
Birmingham
23 June 1995

The objective of this BHS National Meeting is to provide an up-to-date review of current UK research and to stimulate debate on this contentious issue. Groundwater, rainfall & runoff modelling will be covered, at scales ranging from the plot, hillslope, and catchment to the macroscale and the global scale.

Speakers will include Prof Keith Beven and Dr N. Chappell (University of Lancaster), Dr R. Mackay, Dr J. Ewan and Dr C. Kilsby (University of Newcastle upon Tyne), Bob Moore and Dr Pam Naden (Institute of Hydrology), Dr Tim Jolley (University of Westminster), Dr P. Cox (Hadley Centre), Dr C. Onof and J. Tompkins (Imperial College, London).

The venue is the University of Birmingham and all are welcome. The fee is £18 for members (£25 pounds for non-members).

To register or to obtain more information please contact **Dr Tim Jolley**, School of Architecture and Engineering, University of Westminster, 35 Marylebone Road, London NW1 5LS (Tel. 0171 911 5000 ext 3081, Email: jolley.t@westminster.ac.uk)

Conference and field excursion on
COASTAL DEFENCE & EARTH SCIENCE CONSERVATION
Portsmouth
26-27 March 1996

A two-day conference is to be held at the University of Portsmouth to examine all aspects of coastal conservation, management and protection.

Organised jointly by the Conservation Committee of the Geological Society and the British Geomorphological Research Group, the meeting is aimed at local authority engineers and planners, consultants, dredging and minerals companies, as well as at conservation agencies and academics.

There will be a day of papers on 26th March and a field visit to sites on the south coast of England on 27th.

Papers are invited on any aspect of coastal defence and geological or geomorphological conservation. Abstracts (**200 words**) should be submitted by **30th September 1995.**

For preliminary registration and further details, please send your name, address and field of interest to the organisers now.

Convenor: **Dr Janet Hooke**, Department of Geography, University of Portsmouth, Buckingham Building, Lion Terrace, Portsmouth PO1 3HE (Tel. 01705 842482, Fax 01705 842512, Email: HookeJM@cv.port.ac.uk)

International Conference on
ASPECTS OF CONFLICTS IN RESERVOIR DEVELOPMENT & MANAGEMENT
London
3-5 September 1996

Papers (in English) are now invited for this conference at the City University in London. It aims to address technical and administrative issues relating to conflicts between uses and users of water and to review environmental risk and impact assessment of reservoir development.

Themes will include the long-term alternatives to dams and reservoirs, case studies of successes and failures, economic impacts, environmental and social effects, reservoir-related conflict resolution and management.

The venue is the City University, and hotel or university accommodation may be arranged. The conference fees are expected to be under £300 (£150 for accompanying guests). Technical tours to Scotland, Wales and the West Country (costing about £650 to £850) will follow the conference: details will be in the second circular.

Abstracts of **500-800 words** (three copies) should be submitted with the registration form by **30th November 1995.** To register or to obtain more information please contact **Mrs Pat Walker**, International Conference Secretariat, Department of Civil Engineering, City University, Northampton Square, London EC1V 0HB (Tel. 0171 477 8141, Fax 0171 477 8570, Email: pwalker@city.ac.uk)

HydroGIS'96
International Conference on
APPLICATION OF GEOGRAPHICAL INFORMATION SYSTEMS IN HYDROLOGY & WATER RESOURCES MANAGEMENT
Vienna, Austria
16-19 April 1996

HydroGIS'96 is a follow-up to the successful HydroGIS'93 conference in Vienna (IAHS Publication No. 211).

The objective is to exchange experiences in applying GIS and to identify research needs in the fields of hydrology and water resources, agrohydrology, ecohydrology, etc..

The ultimate aim is to help participants to determine critical factors in their evaluation of the applicability and likely benefit of GIS to their own field of work.

Details are available from **the Conference Secretariat:** HydroGIS'96, c/o Austropa Interconvention, P.O. Box 30, A-1043 Vienna, Austria.

Diary

7th June 1995
BHS South West Section Meeting
Field visit to Bodmin, Cornwall
"Floods in the South West"
Venue: NRA South Western Bridgwater
Time: 2.00 p.m.
Contact: Graeme Boyce, NRA South Western Region, Manley House, Kestrel Way, Exeter, Devon, EX2 7LQ
(Tel: 01392 444000; Fax: 01392 444238)

23rd June 1995
BHS National Meeting
"Scale problems in hydrological modelling"
Venue: University of Birmingham
Time: 10.00
Contact: Dr Tim Jolley, School of Architecture & Engineering, University of Westminster *(Tel: 0171 911 5000 ext 3081, Email jolley.t@westminster.ac.uk)*

28th June 1995
BHS Midlands Section
"Taming the Tame"
Venue: Minworth (including site visit)
Contact: Paul Webster, School of Civil Engineering, University of Birmingham, B15 2TT *(Tel: 0121 414 5055, Fax: 0121 414 3675)*

3rd – 5th July 1995
Hands-on PC training course
"Modelling groundwater protection and capture zones with FLOWPATH"
Venue: University of Bradford
Contact: David Lerner, Professor of Environmental Management *(Tel 01274 385470, Fax 01274 383888)* or the Short Course Unit, University of Bradford *(Tel 01274 383217/6, Fax 01274 383218)*

3rd – 14th July 1995
IUGG Assembly (including IAHS Symposia & Workshops)
Boulder, Colorado, USA
Contact: Penny Kisby, IAHS Press, Institute of Hydrology, Wallingford *(Tel: 01491 838800, Fax 01491 692424) or* Dr R Hadley, 3784 S Depew St, Denver, Colorado 80235, USA *(Tel +1 303 986 7130, Fax +1 303 871 2201)*

4th – 8th September 1995
5th National Hydrology Symposium,
Heriot-Watt University, Edinburgh
(see revised leaflet and booking form)

11th – 15th September 1995
XXVIth IAHR Congress: HYDraulics **R**esearch and its **A**pplication next century — *HYDRA 2000*
Venue: ICE, Gt George Street, London
Contact: Dr W R White, HR Wallingford, Oxon OX10 8BA
(Tel 01491 835811)

18th October 1995
BHS Midlands Section
Young Persons' Meeting
Venue: School of Civil Engineering, Birmingham University
Contact: Paul Webster, *address above*

1st November 1995
BHS Pennines Section
"Soil Modelling"
Venue: Newcastle University
Contact: Prof Keith Beven, CRESS, Lancaster University, LA1 4YQ *(Tel 01524 593892, Fax 01524 843854)*

16th November 1995
NERC / BHS / The Geological Society
"Pollutant Transport in Soils and Rocks"
Venue: Inst. of Civil Engineers, London
Contact: Anne Roberts, Institute of Hydrology, Wallingford OX10 8BB *(Tel 01491 692363, Fax 01491 692424 E-mail amr@uk.ac.nwl.ua)*

22nd November 1995
BHS Midlands Section
"Extreme hydrological events in the Midlands"
Venue: *to be decided*
Contact: Paul Webster, *address above*

4th December 1995
BHS National Meeting
"Palaæohydrology"
Venue: Inst. of Civil Engineers, London
Contacts: Dr P L Younger, University of Newcastle; Max Beran, Institute of Hydrology, *addresses above*

21st February 1996
BHS National/Pennines Meeting
"Practical application of quality standards in hydrometry & hydrology"
Venue: Salford University
Contact: Liz Kaar, NRA North West Region, P.O. Box 12, Knutsford Road, Warrington, Cheshire WA4 1HG *(Tel.: 01925 653999, ext. 2131)*

27th – 28th March 1996
CIWEM, ICE & BHS Conference
"Water Environment '96: Supply & demand — a fragile balance"
Venue: ICE, Gt George Street, London
Contact: Lavinia Gittins, CIWEM Conferences *(Tel 0171 831 3110, Fax 0171 405 4967)*

June 1996 (date to be confirmed)
BHS National Meeting with the British Dams Society
"Rainfall and flood forecasting in reservoir design"
Venue: ICE, London
Contact: Dr Hilary Smithers, NRA North West Region, P.O. Box 12, Knutsford Road, Warrington, Cheshire WA4 1HG *(Tel.: 01925 653999, Fax: 01925 415961)*

8th – 11th July 1996
IAHS, BHS
Interceltic Colloquium on Hydrology and Water Management
Venue: Rennes, Brittany
Contact: Alain Jigorel, INSA de Rennes, Département de génie civil, Laboratoire de minéralogie et géotechnique, 20 avenue des buttes de Coesmes, F-35043 Rennes-Cedex, France *(Tel +33 99 28 65 30, Fax +33 99 63 67 05, E-mail: alain.jigorel@insa-rennes.fr)*

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