THE NEWSLETTER OF THE BRITISH HYDROLOGICAL SOCIETY

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WHAT A LOVELY PICTURE!

Or have you got a better one? If so, we would like you to enter it (or them – there's no restrictions on numbers) in our Photographic Competition.

This Competition is open to all BHS members to submit their favourite "hydrological" prints and/or slides to the Editor by *1 August 1985*. First prize will be a year's free subscription to BHS and, subject to the picture's suitability in print terms, we shall ask for your permission to use it for a Society Christmas card – plus, of course, a full front page spread in *Circulation*. The three runners-up will also have their photos featured in future issues of the newsletter.

Existing prints and slides are eligible but I would also ask you all to remember to take your camera when you're out on that field trip, called out to inspect some oddity, or anywhere else with picture potential. If you are taking a shot with the competition in mind, please remember that the Society cannot yet afford colour reproduction for either the Christmas card or the newsletter, so colour film images will need to withstand translation to black and white reproduction, as was the case with the picture shown above, shot originally as a 35 mm colour slide.

Editor

The National Surface Water Archive

Most readers will probably know that care of the national surface water archive passed from DOE's Water Data Unit (now defunct) to the Institute of Hydrology in April 1982. This was the most recent transfer (the Surface Water Survey and Water Resources Board having been responsible along the way) since the Inland Waters Survey Committee started national collation of river flow data in 1935. The 1982 change also involved the British Geological Survey (i.e. their hydrogeology unit at Wallingford) taking charge of the central archive of groundwater levels.

The Surface Water Archive comprises some 17,000 station years of river flow data from over 1,200 gauging stations throughout the United Kingdom. Whilst the network density is comparable with those in other developed countries, the average length of record is less than 20 years and only 6 stations have archived records exceeding 50 years. However a notable milestone was passed in 1983 with the centenary of continuous flow measurement on the Thames at Teddington. In addition to mean daily discharges, the archive accommodates monthly extreme flows and monthly areal catchment rainfall, the latter being currently provided by the Meteorological Office. The flow data are complemented by a register of reference information (the Directory of Gauging Stations) which embraces details of the stations, significant flow statistics and selected catchment characteristics.

The surface water archive is managed alongside other national archives of river flows namely flood peaks and flood events. The former stores all peak flows above a threshold (chosen for a particular station so as to give an average of about five peaks per year). The flood event archive keeps complete hydrographs together with details of the causative rainfall. Together with a growing archive of digitised catchment boundaries and river networks the foundations are being laid for a comprehensive hydrological database.

The initial processing of flow data is mainly carried out by the Water Authorities in England and Wales, the River Purification Boards in Scotland and the Department of the Environment in Northern Ireland. These data are then forwarded, usually on magnetic tape, to the Institute of Hydrology for archival storage. A feature of the IH archiving system is the emphasis on data validation and the use of status flags designed to provide qualifying information to the data user and to prevent the inappropriate use of provisional or poor quality data sets. The IH validation is being developed to complement the field and office procedures operating in the measuring authorities and to provide for statistical checks against the historic flow record, spatial comparisons with neighbouring or analogous catchments, hydrological checks against rainfall and a final visual scrutiny of the annual hydrographs.

There is a broadly-based demand for river flow data and it is IH policy to encourage the fullest utilisation of the archives. A suite of programs enables various forms of retrieval from the surface water archive. The options are described in Surface Water: United Kingdom 1977–80 and, more briefly, in a leaflet about the Archive which accompanies this edition of *Circulation*. Further copies of the leaflet are available, free of charge, from IH — see back of leaflet for address. A small charge is made, to cover computer and handling charges only, for each data retrieval. Special retrievals and analyses can be organised to suit individual requirements.

In recent years surface water archive publications have varied somewhat in format and in the number of years contained in a single volume. The plan for future issues is to have an annual data volume giving information on river flows (there will be a return to full tabulations of daily mean flows for selected stations), catchment rainfalls and (from BGS) groundwater levels. Every five years there will be a supplementary volume with details of gauging stations and a statistical summary. Although they will be available as separate publications, a series of five annual volumes and the supplementary volume will be designed to fit a ring binder and therefore amenable to correction and retrospective insertion. Separate reports will be produced in a matching style to describe significant hydrological events or to give details of the other forms of archive referred to above. A report on the 1984 drought will be the first of these. IH is committed to faster publication of selected archived data. The ultimate aim is to publish one year's data by the middle of the following year. The first target is to complete the 1981 and 1982 volumes by October 1st, 1985 (this happens to be the 50th anniversary of central river flow archiving). Without making rash predictions for the following years, an informed guess would be that 1986 data will be the first to appear on schedule.

Terry Marsh and Mike Lowing

NEWS FROM MEMBERS

A BUG IN THE SYSTEM!

The vulnerability of abstractions for public water supply from lowland rivers to spasmodic pollution has been demonstrated by a number of incidents in recent years, perhaps most notably that on the River Dee in Cheshire in early 1984. For several years Yorkshire Water has been undertaking a programme of work to establish times of travel and dispersion characteristics upstream of its major river intakes.

WRC has been contracted to undertake a number of surveys using bromine 82 as the tracer. This has the advantage that its passage along the river can be monitored in situ. To expand on the information so gained, Yorkshire Water has successfully developed the method for using microbiological tracers for river work, in this case the bacteriophage *Serratia marcescens* has been used. The Authority has a facility for producing bacteriophage suspensions of very high concentration in "commercial" quantities. The phage is dosed into the river and automatic samplers are used at the monitoring stations to collect samples for laboratory culturing and counting. It should be noted that Yorkshire Water has also used microbiological tracers for work on groundwaters, the sea, sewers and sewage treatment works.

From the work done so far, very good relationships between time of travel and river flow have been obtained. A family of curves has, thus, been drawn up for each river relating the time of arrival of a pollution spill at an intake to flow and distance. In the event of an emergency, river flow would be obtained by telephoning the appropriate gauging station.

For further information contact **Tony Edwards** on Leeds (0532) 448201 or **John Watkins** (particularly for phage tracing) on York (0904) 36951.

MEMBERS ON THE MOVE

Stephen Eyre has left the GLC where he worked on the GLC's computerised flood warning system to be the computer manager for the Institute of Neurology, London.

David Plinston has left IH, taking advantage of NERC's Voluntary Premature Retirement Scheme, part of their solution to staff cut-backs advocated in the Council's new Corporate Plan.

LETTERS

Dear Editor,

It would appear that the sexual equality of modern education and training does not extend to the changing of professional attitudes among hydrologists/hydrogeologists. This irony was highlighted in a recent article "Hydrological Education and Training in the 1980s" (No. 5, February 1985). I was irritated by the antiquated use of personal pronouns more suited to professional attitudes of the 1920s rather than the 1980s. I refer in particular to the paragraph: "It would seem that the hydrogeologist can confidently recognize *himself*, *his* profession and the hierarchy of formal bodies representing *his* subject and profession. The poor hydrologist has difficulty in recognizing *himself*, has no clear professional body and a very complex system of representation for *his* subject and professional interests." (My emphasis.) Might I suggest a variation of: their — theirs — them — themself — themselves? This should cover all eventualities.

Dr. Jean Alexander
Hydrogeologist
Fluid Processes Research Group
B.G.S.

RIVER BASIN MANAGEMENT — Hydrological and Hydrogeological Aspects

Joint Geological Society/BHS Meeting
16 January 1985

As we know only too well, Water Authorities both in the UK and overseas are coming under increasing pressure to maintain or improve the many services they provide within stringent financial constraints. An authority's individual functions within a river basin often result in conflicting demands upon available water resources (the use of a river for both sewage disposal and water supply or the effects of land drainage upon existing fisheries being examples). Application of management techniques and modern technology now offers opportunities for effective river basin management and should help to resolve such conflicts in a rational manner. Dr. B.J. Connorton (Thames Water), in opening the meeting, stressed the challenges now facing the water industry and the need for hydrologists to keep abreast of developments in what have previously been peripheral disciplines.

In the first presentation, **Dr. Derek Jamieson** (Thames Water) emphasised the benefits accruing from operating an entire river basin as an integrated system, namely the improved performance from existing capital assets, rational allocation of scarce resources, minimised conflict between the various functions and reduced operating costs. The various uses of a river can be divided into "conservation activities" (water supply, navigation, fisheries, amenity) and "disposal activities" (land drainage, effluent disposal). As different objective criteria are used to assess the performance of these conflicting interests, it would be impossible to aim at "optimal" operating rules for all aspects of river basin management. Instead, Dr. Jamieson advocates a "satisficing" (another Americanism!) approach whereby all parameters of interest are maintained within a satisfactory range, sufficient to support all activities, without any necessarily attaining its optimum value.

Control of the individual subsystems within a river basin, such as pumped wells, sluices and treatment works should be based upon the anticipated rather than current conditions. Such an approach therefore requires reliable short-term predictive models of the component processes, continuous monitoring, extensive telemetry systems and control implemented on a hierarchy of computers. Any undesired change of state (imminent flooding or pollution approaching abstraction points for example) could be predicted and a counteracting decision implemented with minimal delay.

Increased abstraction and sewage disposal in the Thames area has necessitated a level of control hitherto unnecessary, hence the research programme by the authority to establish the systems required for real-time forecasting, decision making and control. It is envisaged that Headquarters involvement will be confined to "strategic" decisions whilst "tactical" decisions such as operation of control equipment to meet the targets imposed by HQ will be implemented by Divisions. At the local level a multiplicity of dedicated micro-computers and processors will receive and process information as to the current state of affairs and initiate any changes dictated from Divisional level. A basin-wide telemetry system is being installed in anticipation of inevitable developments in control technology.

With current advances in microelectronics and systems technology we may be confident that Dr. Jamieson's view of the future will be reality in the Water Industry of the 1990s. The choice seems to be either drifting into automation in a haphazard manner or implementing control procedures in accord with a pre-defined strategy.

Putting away the crystal ball but remaining on the same theme **Professor Enda O'Connell** (Newcastle University) introduced a hypothetical case study, based on the Lambourne scheme, illustrating the use of real-time control in groundwater pumping for river regulation. Again, a hierarchical management approach would be adopted which, with on-line data gathering and automatic control procedures, ensures economic pumping from a network of wells to maintain target flows at abstraction points downstream.

Discussion highlighted the need for certain changes in legislation (and justification for those changes) before the benefits of control can be fully realised. Residual flow in the lower Thames could be lower than the present statutory minimum, allowing increased abstraction as an alternative to additional expensive storage. Similarly, effluent discharged from treatment works could be of variable quality depending upon the accepting capacity of the river; seasonal consents now being introduced may be a first step towards variable consents (and therefore potential energy savings).

Case Studies from the UK and overseas were presented in the afternoon session chaired by **Mike Mansell-Moullin.** The Scottish approach to river basin administration was described by **D.W. Mackay** (Clyde RPB). For the Sassenach audience this was a fascinating glimpse of activities north of the border since the physical and legal constraints are quite unlike those affecting the RWAs in England and Wales. Management of land drainage, flood protection and abstraction was described as a "legislative morass". A riparian owner may exploit river resources as he wishes whilst flooding is the responsibility of the sufferer, with no obligation falling to the local authority to provide protection. The all-important fisheries are controlled directly by angling groups.

Only 1% of all Scottish runoff is used for water supply and re-use is negligible, consequently 95% of rivers are Class 1 whilst less than 0.5% by length are Class 4. Pollution, where it exists, can be very severe however. Of particular concern in Central Scotland is the chronic pollution of watercourses caused by breakout from disused mine shafts, many of which have been used for disposal of industrial wastes. A particular case was highlighted, that of a salmon river which in 1977 received ½ M gpd of acidic, iron-rich minewater. A neat hydrogeological solution was devised; by drawing groundwater off at a higher level much of the deep percolation was prevented, thereby reducing outflow to a few thousand gpd and allowing near-complete stream recovery. Capital and operating costs were significantly lower than alternative solutions such as a minewater treatment plant, sea disposal via pipeline or sealing.

On next to Northern Algeria, an area on the threshold of substantial water resource development for which a planning study has recently been completed. This was described by **John Stowell** (Binnie and Partners). Population in the coastal area north of the Atlas Mountains is anticipated to be double the present 20 million by 2010, with most of this expansion being in towns in the Algiers area. A five-fold increase in demand for potable and irrigation water is anticipated and this will entail using almost half of the potentially available surface water resource. The area contains two major and several minor river basins and a partly confined alluvial aquifer.

Hydrological problems abound; rivers are "flashy", difficult to gauge and capable of carrying enormous sediment loads, suitable sites for regulating reservoirs are few. Water balance figures for the present and future situations indicate decreasing aquifer recharge (due to natural river flows being restricted) and increasing re-use of water returned from irrigation. Progressive deterioration of water quality is envisaged but should not be severe if cautious planning, controls over groundwater abstraction and continuous monitoring schemes are implemented.

Phil Johnson (Northumbrian Water) had but a short time to cover management aspects of Britain's most impressive but oft maligned water supply scheme, Kielder. The reservoir cannot be considered in isolation but forms an integral part of the total resource system of the Tyne-Wear-Tees basins. Water from Kielder, though not strictly necessary given the current downturn in industrial demand, has been transferred to the Tees as part of an operational strategy which seeks to maximise the benefits of yield from all reservoirs in the system.

Control rules have been developed which include guidelines for management of reservoirs in adjacent basins to minimise pumping costs of water transfer whilst maintaining flows for abstraction, riparian and fishery interests. A further objective is to maximise the revenue from hydro electric power generation at Kielder. The CEGB tariff structure has led to adoption of a two season control policy. The generating pattern (and

hence downstream flow) is dependent upon water level in the reservoir and power demand, the latter taking diurnal variation and cold weather into account. We were assured that Tyne fish thrived on a flow regime geared to the human working day!

The final presentation, by **Ken Jones** (Mander, Raikes and Marshall) considered a feasibility study of the water resources and agricultural potential of the Wadi Najran, an alluvial basin in SW Saudi Arabia. Investigations during 1973–74 were to allow quantitative assessment of the existing water resource, show the effect of regulation on aquifer recharge and also to examine the effects of alternative groundwater schemes. Available runoff records were of variable quality, requiring establishment of two new gauging stations, one in a stable channel reach at the head of the Wadi, the other at a downstream constriction on the plain. Wadi gauging is clearly no simple matter — flood flows spread over 10 km width and river course and cross section varied, resulting in over 20 rating curves for a site. Mathematical models developed to simulate runoff, recharge and groundwater flow were used to evaluate proposed flood/recharge control reservoirs and controlled groundwater development. The study showed that some 87% of mean runoff is infiltrated and of this two-thirds is subsequently lost to evapotranspiration. An increased yield of up to 40 M m^3 could be achieved by construction of a dam upstream of the plain to provide flood control and augment recharge for development of a groundwater-based agricultural system.

Mike Mansell-Moullin provided details of the now completed dam. To maximise recharge and avoid major sedimentation the reservoir is kept low prior to flood, ensuring most of the sediment flush is carried downstream. No viable land was lost to reservoir flooding, the only casualty being a principal camel route — this presumably is now a camel expressway as the flood approaches . . .

Rob Henderson

Acid Waters Investigations at Llyn Brianne, South Wales

A major multidisciplinary research programme examining the causes and effects of streamwater acidity and the impact of a variety of land management strategies on the acidity problem commenced in August 1984 in the Llyn Brianne area of the upper Towy catchment in South Wales.



The three year programme is supported by the Department of the Environment and the Welsh Office with a £¼m contract. The research involves scientists with a wide range of disciplines from the Welsh Water Authority, the Institute of Terrestrial Ecology (Bangor), the Institute of Hydrology, the Department of Applied Biology at UWIST, the Departments of Geography and Chemical Engineering at University College of Swansea, the Forestry Commission, and the Departments of Geography at Lampeter and Aberystwyth. The project is co-ordinated by the Welsh Water Authority (WWA) and led by **Dr. John Stoner** (District Scientist, Southwestern Division, WWA) and the project stems from detailed studies by WWA during the past few years on water quality of streamwaters in the Llyn Brianne area.

The research programme has as its primary aim an assessment of the effects of different types of land use (particularly afforestation) and land management practice on stream acidity. With this aim in mind, 12 catchments have been selected for intensive study and instrumentation; 5 catchments are acting as "controls" (mature conifer forest, juvenile conifer forest, oak woodland, unacidified moorland and acidified moorland) and the other 7 are being used to assess the impact of a range of land management "treatments", such as bankside clearance of conifers, standard upland grassland liming, ploughing, etc.

Each catchment is equipped with continuous-recording flow and water quality sensors and data loggers as well as automatic water samplers. The rainfall gauge network includes 3 autographic tipping bucket gauges, all linked to data loggers. An Automatic Weather Station on loan from the Institute of Hydrology provides additional hydrometeorological and climatic data. Bulk atmospheric inputs will be routinely sampled throughout the period. Stemflow and throughfall will be collected within sample plots of each catchment and soil water will be sampled using a combination of tray lysimeters, porous cup samplers and throughflow pits. Water chemistry data at each stage of the vegetation-soil phase of the hydrological system will be used to elucidate the acid runoff generation process. The role of pipeflow in acid runoff generation is a particular topic under investigation, and there are also projects investigating sediment transport and bacteriological streamwater quality and its land use/land management controls. A major ultimate aim of the Project will be the mathematical modelling of water quality in the catchments. Parallel to these hydrological studies are programmes (both field and laboratory-based) investigating streamwater biology, fisheries, toxicity, and aluminium speciation. The major organizations involved in the Research Programme together with their special interests and responsibilities are given below:

Welsh Water Authority —
Water quality, Fisheries, Toxicity studies.

UWIST (Applied Biology Dept) —
Streamwater ecology.

U.C. Swansea (Geog.)/
Institute of Hydrology, Wallingford —
Rainfall and river flow monitoring;
Mathematical modelling of water quality.

Institute of Terrestrial Ecology &
U.C. North Wales —
Hydrology and water chemistry of stemflow, throughfall and soil water.
Role of organic acids.

U.C. Aberystwyth (Geog.) —
Pipeflow and pipeflow chemistry.

U.C. Lampeter (Geog.) —
Sediment; bacteriological studies.

U.C. Swansea (Chem.Eng.) —
Aluminium speciation studies.

Forest Commission —
Silviculture practices and their impact.

R.P.D. Walsh
I.G. Littlewood

Research Opportunity

NERC have awarded a research studentship to Imperial College, in collaboration with the Institute of Hydrology, for research on the effect of aquifer inhomogeneity on saline intrusion in coastal aquifers. The project offers research training in field experimentation and numerical modelling applied to a problem of major practical importance for coastal aquifer management. For further details, contact Howard Wheater, Department of Civil Engineering, Imperial College, London SW7 2BU.

Hydrological and Pollution Aspects of Airport Drainage

Joint Institution of Public Health Engineers/BHS Southern Section Meeting
5 February 1985

Airports provide an extreme form of urbanisation and have a number of particular problems associated with them. Over 60 hydrologists and public health engineers came together to discuss this interesting type of land use change.

Derek Netherton, Chairman of the Metropolitan District Centre of IPHE, welcomed BHS and IPHE members to what he hoped would be the first of many joint meetings of the two societies. For convenience the meeting was divided into hydrological and pollution aspects, but it was emphasised that in practice the two could not always be readily separated.

The first speaker was **John Stowell** (Binnie and Partners) who described the hydrological aspects. He was speaking to a paper produced by his colleague, **Fred Kaul**, who was working abroad, but said this gave him an advantage in that he could always claim ignorance if faced with difficult questions! The construction of an airport involves large "impervious" areas of runways, taxiways, terminal area, etc. Associated with these are networks of pipes and drains to carry storm water from these areas to a receiving watercourse.

A number of design flood hydrographs were presented for a 3 km^2 area. The Flood Studies Report was used for the existing rural catchment, and FSR Supplementary Report 5 and CIRIA Technical Note 100 were used for the proposed airport. The latter methods gave similar results when constrained to use the same proportion actually impervious. The graphs demonstrated the large effect of urbanisation on both the magnitude and speed of response. Neither TN100 or FSSR5 have been recommended for fully sewered catchments, but it was suggested they might provide an easier and cheaper alternative to the Wallingford procedure (WASSP) for certain situations.

Just as airports may effect the flows in watercourses downstream, so land use changes in the catchment upstream of an airport may create problems in drainage at the airport itself. The example of Brunei airport was quoted, where cross-drainage from natural watercourses is conveyed across the airport by culverts under the main runway. With urbanisation of the land surrounding the airport the 100 year design flood into the culverts is expected to double. The culverts are not adequate to pass these flows, necessitating construction of detention ponds and a bypass channel around the perimeter of the airport.

Balancing ponds are used to constrain outflows downstream, and in their design the estimation of the percentage runoff is clearly of great importance. However both TN100 and FSSR5 were based on data from relatively few urban catchments leading the speaker to call for more fieldwork to collect data, especially from very small catchments for which the effects would be most extreme. He was also concerned about the present inability to model the outflow of drainage systems resulting from storms greater than the system design level.

John Packman (IH) had experience in the development of not only FSSR5 and TN100, but also WASSP. He commented that neither of the first two methods were designed for highly impervious areas. Both were primarily based on data for large catchments, having up to about 30% area paved. He supported John Stowell's call for more data to be collected. He suggested that the WASSP sewered subcatchment model would have been the most appropriate technique to use in the case study described. John Stowell agreed that FSSR5 and TN100 were not ideal, and had been used as examples of well known techniques. The particular study described had pre-dated WASSP, and in future work he would probably include the sewered subcatchment model. The problem of adequately describing the magnitude of infiltration losses for "impervious" areas was another aspect that had changed in the last few years. Traditionally, about 90% runoff had been assumed but now it was recommended that 70% runoff from impervious areas be used. The mechanism of the losses was discussed and the importance of localised sinks through joints in the surfaces was suggested. This was opposed by some of those present who were more closely allied with the construction industry!

The second speaker was **Joe Stewart** (Binnie's) who described the pollution aspects of airport drainage. These are often very difficult to quantify, and as an example he asked for suggestions of how to measure the concentration of oil when it occurs as a two-dimensional film? Airport pollution arises from a number of activities. Detergents are used to clean aircraft and service vehicles. Although these are usually biodegradable, the retention times in drainage systems are usually too short for this to be significant before they reach the receiving watercourses. They may interfere with oxygen transfer and exert a BOD, especially in summer with higher temperatures.

In winter, de-icing of aircraft and runways may cause pollution. The two main products in use are glycols and urea. Salt is not used due to its corrosivity (we look after aircraft better than we do our cars!). Glycols are effective at dealing with ice but have a very high BOD (typically 300,000 mg/l), although the effect is usually much less due to the low winter temperatures. Urea is almost non-corrosive and is being used increasingly. Spillages of fuel oil are difficult to deal with and are best treated as close to the source as possible with techniques such as floating booms, and API separators. For the hydrologists present this gave a new meaning to the initials API — American Petroleum Institute! **Brian Ellis** (Middlesex Poly) asked how often consent standards were violated. Joe Stewart said there were too few data to make judgements. He emphasised the need to deal with percentiles rather than maximum concentrations. **John Ryan** (Thames Water) posed the question "Is runoff from airports surface runoff or a trade effluent?" He recounted that in the recent cold spell his authority had temporarily to close down potable water intakes downstream of a military airport due to the high concentrations of urea.

Mark Robinson



De-icing aircraft.

A View Across the Thames Valley — the London Weather Radar Project

BHS Southern Section Meeting
11 March 1985
(held jointly with I.C.E.)

The meeting was chaired by Peter Lee of the Greater London Council who reminded the group that it was just over 40 years earlier at Daventry on 26 February 1935 that the first practical demonstration of radar for detecting aircraft was given. The presenters had all been involved with the London Weather Radar Project (LWRP); Geoff Clift (CNS Scientific and Engineering Services) as project manager, Chris Collier (Met. Office) as Chairman of the Implementation Working Party and Brian May (Met. Office) as a member of one of the LWRP's research subgroups.

Geoff Clift opened the meeting by describing the history and implementation of the LWRP. He emphasised that the London radar was the most recent product of many years of work by the Met. Office into weather radar. The Dee Weather Radar Project (1973–77) was the precursor of all the UK radars. The project demonstrated that radar could measure rainfall over large hilly areas more cost-effectively than telemetered raingauges. In the period between the Dee project and the London radar, radars were installed at Hameldon Hill, Lancashire; Clee Hill, Shropshire; Upavon, Wiltshire and Cambourne, Cornwall. The south-east of England was poorly covered by the Upavon radar and although a proposal for a London radar was made in 1973 it was not until February 1982 that a consortium, formed of the Met. Office, GLC, TWA and SWA, was established to implement the radar. The Met. Office had completed much work prior to the formation of the consortium, principally the selection of the site at Chenies from over 100 possible locations. The change in central Government policy after 1979 affected the process by which the equipment was obtained. Hitherto the Met. Office had purchased all the components and assembled the system. At Chenies, Plessey was appointed to procure most of the system with the Met. Office providing certain components and the software. The radar was installed at Chenies in February 1984 and in May was officially accepted by the Met. Office from Plessey. Telecommunication problems delayed the arrival of useful data to the members of the consortium until the autumn of 1984. The radar system was officially declared operational on 16 January 1985. Currently the Chenies data are combined with data from the other UK radars and used for quantitative meteorological forecasts. The individual water authorities and the GLC are receiving sub-catchment data which can be used for hydrological forecasting. Looking to the future, the Working Group on National Weather Radar Coverage reporting in 1983 identified a further six sites which would be required to complete coverage of the UK. Moving to the international scale the COST 72 (European Co-operative in the Field of Scientific and Technical Research) European Weather Radar Project envisages 127 radars forming an integrated weather radar network. Chenies is one of the first of these radars to be operational.

Chris Collier then presented a description of the real-time estimation of rainfall using radar data. He emphasised how the results of the Hameldon Hill radar were being applied to the Chenies radar. As more experience was gained so the learning curve flattened with the consequent result that useful data could now be made available earlier than it had been in the past. One such area was the real-time adjustment of radar data. The Chenies radar rainfall estimates are adjusted in real-time using data from five telemetered tipping-bucket raingauges. The on-site computer calculates ratios of radar rainfall total (R) to raingauge total (G). An analysis of each set of R/G ratios and all previous ratios in the preceding hour is used to determine the rainfall class; frontal showers, rain shadow, bright-band or showers. The radar rainfall values are then adjusted over domains that are pre-defined for each rainfall class using appropriate values of R/G. Using this procedure at Hameldon Hill it was found that the raingauge calibration procedure significantly improved the accuracy of estimates of surface rainfall within 75 km of the radar site when assessed against raingauge data. A similar analysis for the summer and winter halves of the year indicated that, in winter, at ranges greater than 75 km, the radar significantly under-estimated the rainfall amounts. At Hameldon Hill the spatial variability of the reliability of the radar data led the Met. Office to produce a map for the NWWA which displayed those areas where the hydrologist should use either calibrated radar data or telemetered gauges. Turning to Chenies it had been found that the blocking effects of the on-site masts and pylons were visible when the data were integrated over a 24 hour period. At the 5 and 15 minute integrations these effects were invisible. Similarily, although there were problems of ground clutter in Central London they were no worse than those at other sites. Preliminary performance statistics suggested a data availability of 90% which was comparable with other sites. Down-time was primarily due to planned mainenance of the hard- and software.

Brian May presented a summary of the Met. Office's work on the PARAGON system. PARAGON is the acronym for Processing and Archiving of Radar and Gauge data Off-line and in Near-real-time. The work he described was concerned with non-forecasting purposes and viewed the radar data as satisfying the need for rainfall data which had a wide coverage, frequent observations and fast data acquisition. Radar is especially useful for sub-daily values In contrast to the 3,400 locations in England and Wales where the rainfall totals are read daily, only at 150 locations are totals collected at sub-daily intervals. With such a sparse sub-daily network localised intense storms can occur undetected between gauges. The aim of PARAGON is to combine the precision of measurement from rain-gauges with the spatial and temporal variations observed by the radar to provide a better representation in both time and space than either system gives alone. PARAGON derives a rainfall surface by adjusting radar estimates of rainfall by a spatially varying calibration factor to bring them into agreement with the general level of rainfall as measured by the raingauges, whilst simultaneously allowing the radar to contribute to the definition of rainfall distribution between gauges. Three examples of the use of PARAGON are the improvement of daily rainfall data for use in the real-time operational advisory water balance scheme (MORECS), investigations of sub-daily rainfalls for flood-producing events and the quality control of gauge data. Anticipated further uses included automatic selection and cataloguing of heavy rainfalls and the development of a morphology of their occurrence.

DISCUSSION:

Mike Lowing (IH), noting that the Met. Office had provided a map to NWWA showing areas where gauges should be used in preference to radar, wondered if more telemetered gauges were the answer rather than more radars. Chris Collier replied that although telemetered gauges could be relied upon to give accurate point estimates, to provide a coverage over large areas a radar based system was more cost effective than one based on telemetered gauges. Lowing then asked whether radar data would be available on Prestel in the near future. It was noted that the Met. Office were considering such a service but that the images would be both temporally and spatially coarser than the imagery supplied to client water authorities.

Roger Goodhew (Severn-Trent) asked what procedure had been adopted in selecting the Chenies calibration gauge in the built-up area of London and enquired as to the existence of a national policy on such gauges. Chris Collier stated that in addition to standard Met. Office gauge site considerations it was also necessary that the gauge was not located in an area of ground clutter. A national policy was in the process of being formulated and was based on the experiences to date of providing calibration gauges for the radars.

Paul Jowitt (Imperial College) asked whether or not "expert systems" had been considered as a means of identifying bright-band, Anaprop and other spurious echoes. Chris Collier noted that expert systems

tended to use a sequential analysis methodology whereas the phenomena under scrutiny were almost transitory. To date, it had been Met. Office practice to employ a meteorologist who interpreted the imagery using physics-based techniques.

M. Lindley (Rofe-Kennard and Lapworth) asked whether or not radars which overlapped gave the same results. Chris Collier replied that this had not been thoroughly investigated by the Met. Office because the beam characteristics, ranges and elevations at a point of overlap would be different which would inevitably complicate any such analysis. Met. Office procedure was to define boundaries between radars by calculating the heights of each beam above sea level (allowing for any obstructions) and taking the lowest.

The meeting was closed with a vote of thanks by **Jane Bliss** (BHSS Committee/ CEGB) and members went on to inspect a poster display which described the GLC's computerised flood warning system (see "Circulation", November 1984).

W.S. Eyre

BOOKS

About 30 publishers and international organisations were asked if they would provide books for review. Responses varied: encouragement and books from all the international bodies; a catalogue from one publisher with an offer to choose books of interest; books from some other publishers; silence from most others. Nevertheless, enough books are coming to allow book reviews to be a regular feature.

More reviewers would help: volunteers to date have not matched the books received which are in the fields of urban hydrology, open channel hydraulics, geomorphology and climatology.

Please write to David Lerner, Department of Geological Sciences, University of Birmingham, P.O. Box 363, Birmingham B15 2TT.

GUIDELINES FOR DRINKING WATER QUALITY. Vol. I: Recommendations. *World Health Organisation*, 1984, 130 pp.

Is it hydrology? There are two reasons for reviewing this book in *Circulation*: it is relevant to anyone involved in water resources and water supply, especially in the third world, and it is an excellent book. It replaces two previous WHO publications, *European Standards for Drinking-water* (1970) and *International Standards for Drinking-water* (1971). Of course the new book is not directly applicable to the UK or Europe where EEC directives reign, but it is still worth having on your bookshelf.

Clearly written (inconceivable that a committee could have achieved this but there is no hint of the identity of an individual author), it discusses priorities for water quality, the nature of the limits set and briefly summarises the evidence for the limits for the non-specialist. (Volume 2 consists of detailed monographs on individual substances.) Ways to apply the guidelines, monitoring, and possible remedial actions are discussed with the authors resisting many of the useless generalisations that usually happen when trying to apply one set of rules to the whole world.

One theme running through the book is that food and air are also routes for dangerous substances to reach human beings; if only 1% of the acceptable daily intake comes from water, a higher concentration can be accepted. A second theme is that guidelines can only be set if

(a) there is good evidence that the substance is dangerous;
(b) it has been detected frequently in water;
(c) analytical methods are available;
(d) methods of controlling concentrations are available.

The rules for selecting substances means that only 18 organic compounds have guidelines, despite the fact that over 1,200 have been identified in drinking water. Of course, not all were found in the same sample, but the Water Research Centre identified 324 compounds from only 14 samples – and about 90% of the total organic carbon (TOC) remained in unidentified compounds.

These guidelines depart from previous WHO and current EEC practice by not setting limits on classes of organic compounds. Although TOC, for example, is appealing as a parameter that avoids the difficulty of identifying compounds, it is too crude. Small concentrations of highly toxic compounds will be concealed by all the commoner, less dangerous, solutes, and changes in the compounds making up the TOC will not be revealed.

In my limited experience, hydrologists find inorganic and organic water quality easiest to deal with. But WHO state that microbiological and biological quality are of the greatest importance and "must never be compromised". One egg of a parasite or one virus is enough to infect the drinker, whereas lethal concentrations of chemicals are only likely to occur after a massive pollution incident. A particular problem in rural areas may be persuading the population to drink unpalatable but safe water instead of sweet tasting but microbiologically polluted water which is usually also from the closer source.

WHO publications are available through Her Majesty's Stationery Office, tel: 01-622 3316.

FINITE ELEMENTS IN WATER RESOURCES. Proceedings of the 5th International Conference, Burlington, Vermont, USA, 1984. *Computational Mechanics Centre and Springer-Verlag.* 823 pp. £49.

The 68 papers in this volume can be classified as follows:

Type of paper	*Subject of paper*						
	Numerical methods	*Groundwater flow*	*Transport in groundwater*	*Oceans, lakes, rivers*	*Navier-Stokes*	*Sedimentation*	*Total*
Explanation of a natural phenomenon				1			1
Case study		1		1			2
Theory with no applications given	2	2			1		5
Theory, with results for an artificial case		5	6	5	1	1	18
Theory, with prediction for a real situation without calibration	2	2	1	5	1		11
Theory compared to analytical solution	2	4	5	6	1		18
Theory compared to real data		7		5			12
Review	1						1
Total	7	21	12	23	4	1	68

Papers which are noticeable as being in minorities include one explaining the circulation of oceans over the continental shelf and a good paper on groundwater in islands demonstrating that vertical flows are important despite the universal use of the Dupuit-Forcheimer assumption. Perhaps the best paper is about modelling storm surges using Dunkirk Harbour and the Channel as examples. But these are exceptions. Most papers are short and are not about the real world – look how many predict results for artificial situations, or worse, for real situations without proving that the model or method can be applied. Only very few of the 20% which contain comparisons with real data can be said to have proven their applicability.

Finite elements were clearly the interest of the conference, not water resources. So if you are struggling for a method (for example, to model groundwater flow when the ground is freezing up) look in here.

Other publications received:

Toxicological appraisal of halogenated aromatic compounds following groundwater pollution. *WHO*, 1980, 58 pp.

Heptachlor. Environmental Health Criteria 38, *WHO*, 1984, 81 pp.

Endosulfan. Environmental Health Criteria 40, *WHO*, 1984, 62 pp.

Flow through porous media. Edited by G.F. Pinder. *CML Publications, Southampton,* 1984, 150 pp, £20. This is a collection of the "best" papers on groundwater flow that have appeared in the journal *Advances in Water Resources*; discussions and some addenda by authors are included. All are highly mathematical.

FORTHCOMING EVENTS

Meetings

HYDROCAD '86
International Conference on Computer Aided Design in Hydraulic and Water Resources Engineering. Budapest University of Technology, Hungary.
9–11 July 1986.
Sponsored by IAHR.

Topic 1: Data base management for CAD.
Topic 2: Mathematical methods for CAD and planning.
Topic 3: CAD, planning and operation: application and case studies.

Pre-registration forms and more details from: Hydrocad '86 Organising Committee, H-1055 Budapest, Kossuth Lajos Ter 6–8, Hungary.

UNESCO IHP-III SYMPOSIUM
DECISION SUPPORT SYSTEMS AND RELATED METHODS IN WATER RESOURCES PLANNING
Oslo, Norway.
5–7 May 1986.

Topics: Public participation in decision making and water resource planning; Economic quantification as a tool in decision making and water resource planning; Prescriptive decision making models; Graphic techniques as a tool in decision making; Future possibilities.

Deadline for abstracts of papers: *14 May 1985.*

Further details from: Decision Support Systems Symposium, c/o A. Carlsen, Ingeniør A.B. Berdal A/S, Kjørboveien 14, 1300 Sandvika, Norway.

REMOTE SENSING APPLICATIONS IN GEOMORPHOLOGY AND HYDROLOGY
8-9 January 1986.

A two-day meeting co-sponsored by BHS, and the Remote Sensing Society and the British Geomorphological Research Group at the Annual Conference of the Institute of British Geographers, to be held at Reading University.

The provisional programme will consist of state of the art reviews, followed by concurrent sessions of submitted papers and image processing displays (from the Reading Group) and then on Thursday afternoon a visit to the National Remote Sensing Centre (RAE Farnborough) and the Institute of Hydrology (Wallingford).

Abstracts (one page) should be submitted to the convenors: Dr. A.C. Millington and Dr. J.R.G. Townsend, Department of Geography, University of Reading, Whiteknights, Reading, Berks, RG6 2AB by *31st MAY* at the latest.

Courses

Imperial College London
MATHEMATICAL MODELLING OF GROUNDWATER FLOW

A short course on "Modelling transport phenomena in porous media" is to be given by Jacob Bear of the Technion, Israel at the Department of Civil Engineering, Imperial College from 10–12 July 1985. The mathematical description of fluid movement in porous media has become of increasing significance in recent years, particularly in groundwater management, environmental engineering and agricultural water management as well as in petroleum engineering. The aim of the course is to provide the theoretical background and rationale for the current methods in the modelling of transport phenomena in porous media. The course will be of particular interest to research engineers and scientists but also to practising modellers.

For further details please contact: Dr. H.S. Wheater or Paul Johnston at Dept. of Civil Engineering, Imperial College, London SW7 2BU, tel: (01) 589 5111, ext. 4736 or 4871.

FIELD STUDY COURSES ON WEATHER

The Royal Meteorological Society runs residential courses on various aspects of the weather every year. Topics include: Weather and Plant Ecology (26 July–2 August), Weather in the Hills (2–9 August), Understanding Weather (9–16 August), Weather Science and Weather Forecasting (21–28 August) and Weather and Bird Movement (7–13 September). Fees range from £70 to £123. Further details from the Executive Secretary, Royal Met. Soc., James Glaisher House, Grenville Place, Bracknell, Berks RG12 1BX.

INTERUNIVERSITY POSTGRADUATE PROGRAMME IN HYDROLOGY

Sponsored by the Belgian Committee of the International Hydrological Programme (IHP) and by UNESCO.

Formal instruction over one or two years. First year: leading to a Diploma in Hydrology or a Certificate, includes, Prerequistes (if necessary); Basic Courses (410 hrs)(open channel hydraulics, hydrometry, general meteorology and climatology, hydrometeorology, surface water hydrology, groundwater hydrology, probability and statistcs, systems approach to water management, Part I: introduction, water quality, water treatment and water supply, introduction to computer science and the use of hydrological databases, introduction to computer programming); Field training (30 hrs).

Second year: leading to a Master's degree in Hydrology, includes, Optional Courses (minimum 190 hrs); Orientation A: Surface Water Hydrology (synoptic meteorology, advanced hydraulics, advanced surface water hydrology, watershed management); Orientation B: Groundwater hydrology (flow through porous media, advanced geohydrology, hydrogeology, geophysical prospection, applied mathematical methods); Orientation C: Water Pollution Control (water chemistry and water quality, water quality models, hydraulics of waste water collection and water supply, waste water purification and water treatment); Common to all orientations (systems approach to water management, Part II: basic concepts, statistical applications in hydrology, teledetection techniques, damsites and drilling techniques); Seminars (30 hrs); Field training (90 hrs); MSc. thesis.

The programme is located at the Faculty of Applied Sciences, Free University Brussels (VUB) in Brussels and is supported by the Universities of Antwerp, Ghent and Leuven. Courses start September 1st of each year. English is the medium of instruction. Students who obtained a Bachelor's degree (BSc. or Eng.) or its equivalent (Licence) will be considered for admission.

Further information, including a brochure with application form can be obtained from Prof. Dr. ir. A. Van der Beken, Director of the Programme, Laboratory of Hydrology, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium. Telex: 20064 VUBHYD-B.

Fellowships are available within the framework of:
- bilateral agreements with Belgium, applications must be introduced by national authorities at Belgian Embassies;
- multilateral programmes through United Nations Agencies, applications must be introduced through the intermediate action of the UN regional representatives or the UN Department of Technical Co-operation for Development;
- exchange programmes as part of the International Cultural Agreements of several nations with Belgium; applications should be made through the appropriate authorities at the Belgian Embassies.
- programmes of international organisations (e.g. UNESCO-Participation Programme, WMO, EEC, etc . . .).

Copy Deadline for Issue No. 7 – Monday, 1st July 1985

Research Funding

Dr. J.A.A. Jones Geography
University College of Wales, Aberystwyth.

Effects of accelerated throughflow processes on water yield chemistry under acid rainfall. (NERC.) In collaboration with Dr. J. Stoner, Welsh Water and Dr. M. Hornung, I.T.E.

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