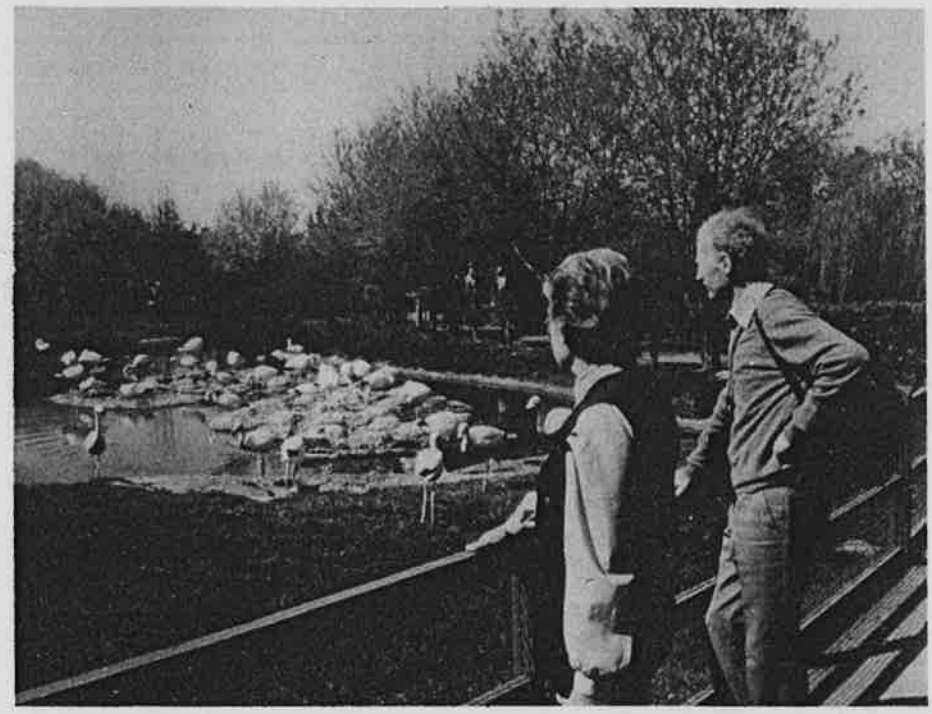
THE NEWSLETTER OF THE BRITISH HYDROLOGICAL SOCIETY

Circulation

No.7 August 1985

MANAGEMENT OF WETLANDS

Joint BHS/Welsh Hydrological Group/ Institute of Biology Meeting 8 May 1985



Marie Lindley and John Cole with the flamingoes at Slimbridge

Over 150 hydrologists, biologists and others interested in the managment of wetlands met at Slimbridge. Before the meeting began delegates were treated to a guided tour of the Wildfowl Trust, featuring such diversions as synthetically dyed flamingos and a demonstration for favoured visitors of the courtship ritual of the Australian spine tailed duck, all viewed on a brilliant sunny day.

The audience were thus in a receptive mood as **Mike Mansell-Moullin** opened the day's proceedings on behalf of the BHS. He introduced Professor **Geoffrey Matthews**, Director of Research at the Wildfowl Trust whose role was to set the scene for the papers to follow. Professor Matthews welcomed the audience on behalf of the Wildfowl Trust. He explained that the International Wetland Year would begin in September 1985 and with a view to publicising its aims two colleagues (Dr Wolff and Dr Noble) had produced a synchronised tape/slide show on behalf of the International Council for Environmental Education. Professor Matthews had recorded the English commentary and proposed to use those present as guinea-pigs for the presentation, entitled "Understanding Wetland Ecosystems".

The point was emphasized that only 3% of the earth's surface could be categorised as wetlands and that this proportion is under increasing pressure for development. There were three main themes to the presentation:

1 Maintenance of ecosystems
2 Preservation of genetic diversity
3 Sustainable utilisation

The slides and associated commentary proved very interesting and provided a valuable framework in which to slot the following papers both in their geographical and ecological context.

The next speaker, Dr **Ted Hollis** from University College, London, described a specific example where international interests proved an additional layer of complexity on top of an already difficult management situation. His paper dealt with the modelling and management of the internationally important wetland at Garaet el Ichkeul in Tunisia. These marshes provide a wintering area for an estimated population of 300-400,000 waterfowl (mainly wigeon, pochard, coot and greylag geese).

The national water resources plan for Tunisia defined a strategy which included a requirement to dam and divert all six of the rivers which flow into Ichkeul resulting in some 75% of the normal inflow being exported from the catchment. Even with the natural flow regime the lake level fluctuates over a range of 1 m to 1.5 m and during the summer the outflow from the lake reverses and saline intrusion becomes a problem. As the abstraction from the inflow to the marsh increases it has become necessary to control this saline intrusion. A sluice will be built on the out-

flow channel and this is expected to be enough to maintain the present ecological balance until the third dam in the sequence of six is completed in 1989. Studies have shown that the area of food plants available for the over-wintering wild fowl can be expressed as a function of lake level (L) and lake salinity (S) during the preceding winter. The equation used is:

$$\text{Area of food (km}^2) = 20.03 - 0.24L - 0.47S$$

To assess the effectiveness of a variety of management options it has been necessary to model the two components of the relationship. The lake level could be modelled with acceptable accuracy but calculating the value of salinity proved more difficult.

It appears that there are two possible ways to assure the survival of the wetland ecosystem. The first is to build a bund across the lake and accept that the seaward side will be permanently saline. The alternative involves diverting water from a neighbouring catchment to maintain the balance between fresh and salt water. Dr Hollis brought his lecture to a novel and thought provoking conclusion by trying to demonstrate the political links between the various bodies charged with studying the management of Ichkeul. This bore some resemblance to a well ordered spiders web but that was before the various personal and dynastic relationships were added. The result looked like a blown-up picture of a microchip but without the underlying order.

It was suggested during the discussion that perhaps the later dams could be postponed but it was pointed out that the water resource scheme was of the highest national priority to Tunisia and that the welfare of the wild fowl would have to be accommodated within that priority.

The meeting then adjourned for lunch, taken as a picnic in the open air and full advantage was taken of the fine weather and fascinating surroundings.

The first session after lunch was led by **Peter Beale**, Chairman of the ecological group of the Institute of Biology. He introduced Dr **Malcolm Newson** and **Kevin Gilman** from the Institute of Hydrology at Plynlimon. They described the genesis of wetlands in Great Britain. In the uplands of the north and west rainfall was relatively high and evaporation relatively low leading to wetland being the natural order of things whilst in the lowlands of the south and east there were tracts of land where poor drainage and a supply of water from high land generated fens, levels and marshes. Malcolm Newson traced the destruction of the wetlands back to the introduction of the Belgic plough and the consequent agricultural use of the wetter forested lowlands. This historical overview continued with a vivid slide featuring hobgoblins of marsh gas showing the spirit of the fens before the drainage of the seventeenth century. Having set the scene Malcolm Newson gave way to Kelvin Gilman who described a programme of field work carried out in Anglesey. The first essential in the understanding of wetland hydrology was a thorough understanding of the morphometry of the site. Until this information had been gained it was often difficult to ascribe a direction to the flows involved, let alone decide their volume.

The Anglesey site was then instrumented with the obligatory weather station plus flow gauges and a transect of boreholes across the site to measure groundwater movement. Geophysical surveys backed up by augering and peat coring were carried out to determine the available subsurface storage and conductivity samples used to decide the source of this water. The experience gained in this work has enabled the authors to offer a consultancy service to those engaged in the conservation of threatened wetlands. Newson and Gilman offered a matrix in which to slot such sites as an aid to a quantification of the issues involved.

Source of waterlogging	*Area in Ha* 50	50–1000	1000 Ha
Rain	R1	R2	R3
Springs	S1	S2	S3
Floods	F1	F2	F3

Against this classification could be laid the principal threats including intensive agriculture, gravel abstraction, water abstraction, forestry roadbuilding and river management.

Following the paper by Newson and Gilman defining the hydrological research framework came a presentation by Dr **Margaret Palmer** of the Nature Conservancy doing the same for ecology. Dr Palmer started with a quote from Charles Kingsley lamenting the drainage of Whittlesey Marsh in the nineteenth century. In order to set the scene some slides of West Sedgemoor were displayed showing the classification of aquatic vegetation into three broad types, submerged floating and emergent. West Sedgemoor is a Site of Special Scientific Interest, part of the 25,000 hectares (0.1% of the land area of Great Britain) of grazing marsh so designated. Of this total the three largest areas, each more than 5,000 hectares, are the North Kent Marshes, the Petestone and Westlooge levels in South Wales and the Somerset Levels.

A study of the vegetation of the latter area has led to the classification of the ditch flora into six types from Type A found in large (> 4 m) open water ditches and characterized by the yellow water lily to Type F from small neglected ditches and dominated by grasses.

Having classified the existing vegetation Dr Palmer focussed our attention on the effects of arable agriculture, this time in the Pevensey Levels. The major changes were that the length of ditch per unit area within the arable area was reduced by 40% and there was a marked increase in the concentration of dissolved salts in the ditch water.

The fruits (ecological terml) of this labour were to produce a management recommendation for SSSIs. The key points are:

1 Maintain ample supply of water.
2 Flush system in winter.
3 Limit use of artificial fertilizers.
4 Assure variety of ditch widths, depths and profiles.
5 Reprofile a section at a time to enable vegetation to recolonise quickly.

The meeting then adjourned for tea, the volume of information being presented being too great to allow any time for questions.

The last two papers of a full day's session were chaired by **Bob Drayton** from UCW, Cardiff and were concerned with the engineering and economic management problems associated with managing wetland in the 1980s.

Firstly **David Brown** of Lawrence Gould Consultants presented an account of a study of the benefits which could be accumulated if the Lower Brue valley in Somerset was more intensively farmed.

The original study encompassed an area of 11,000 hectares but the preliminary field research reduced this to a potential area of benefit of 4,700 ha. The most serious management problem in this area was that of summer flooding, it being accepted that occasional winter inundation was inevitable. It is relatively simple to establish an upper limit of potential benefit which at least can confirm that the second phase of the study should be undertaken.

This phase is the all important field work element conducted by a systematic programme of interviews, concentrating especially on those who would implement any proposed improvement, the farmers affected. In the case of the Lower Brue study two important factors were determined. Firstly some farmers had been able to carry out improvement work in isolation and their experience gave valuable ground truth for the evaluation of benefits. Secondly, it was discovered that many of the land holdings in the valley are so fragmented that even if an improvement scheme was implemented many farmers would not be able to take advantage of it.

Mr Brown then changed the direction of his talk from the particular to the general. He explained that the EEC currently produces about 20% more temperate foodstuffs than it needs. These surpluses are expected to grow due to technical development such that by the year 2000 some 19% of the land in use for agricultural products would need to be taken out of use simply to maintain the current level of surpluses. This analysis suggests a declining requirement for large scale land drainage schemes.

After ending on this thought-proving note, Mr Brown was asked about the possibility of reducing output by low-input production. His opinion was that this had only a limited scope and that it would still be necessary to positively discourage farming to achieve the desired reduction.

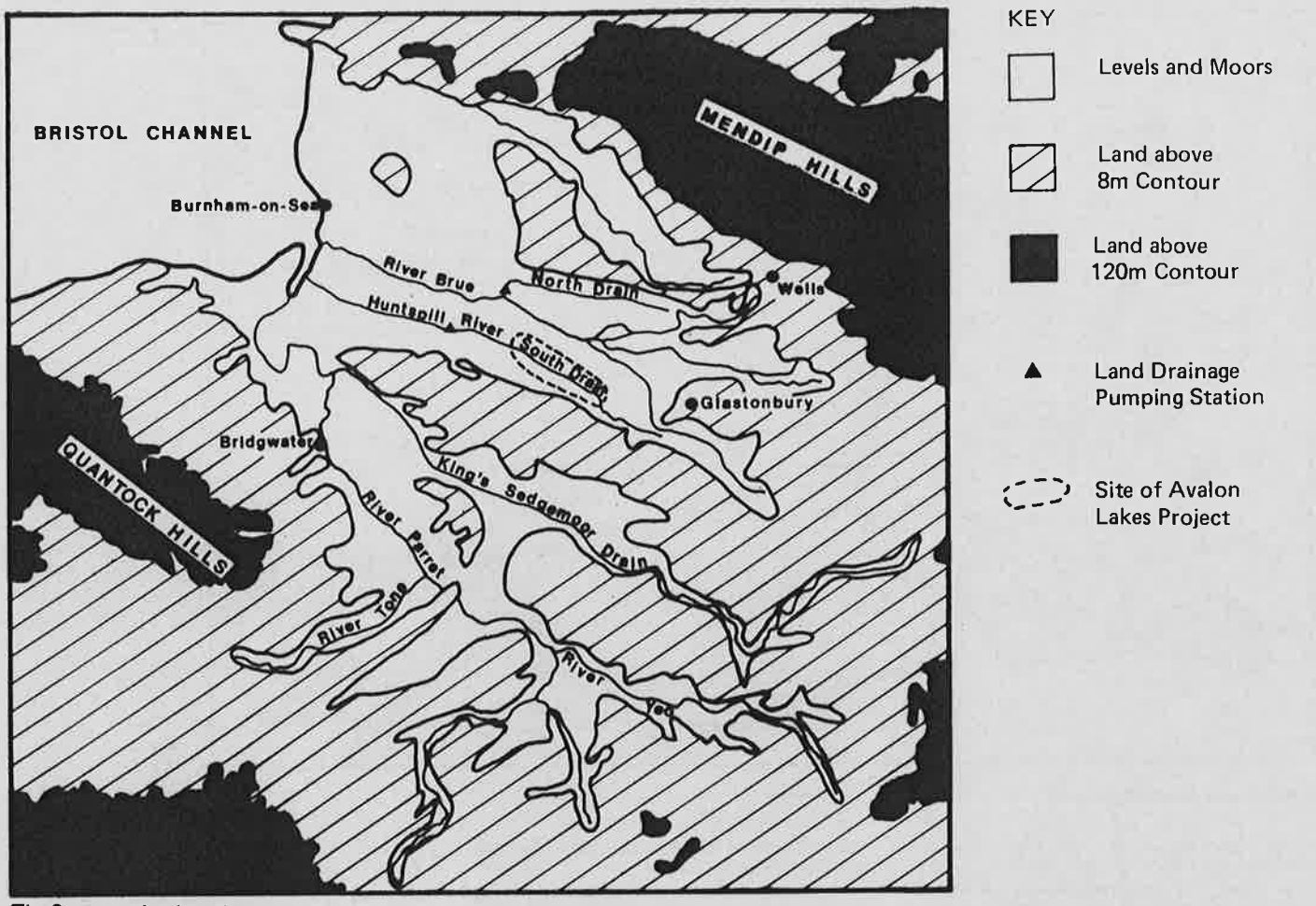
The final paper of the day was given by Dr **Terry Newman** from Wessex Water Authority. It concerned the studies that the Water Authority was undertaking to optimise the use of completed peat workings, again in the Lower Brue valley. Dr Newman trumped the opposition in the historical framework stakes reminding the audience that it was 300 years since the course of English history was diverted by an early attempt at land drainage when the Duke of Monmouth lost the Battle of Sedgemoor because of an unmapped drainage ditch. He also argued that land drainage was a positive force for conservation in that the present Somerset landscape is a product of over three centuries of progressively more efficient drainage.

The Avalon Lakes Scheme was conceived to offer a mixture of benefits, especially flood alleviation, agricultural and public water supply, recreation and conservation. The investigational programme fell into four categories:

1 Engineering — construction methods and cost.
2 Biology — effective management of eutrophic waters.
3 Chemistry — character of source waters and stored waters.
4 Hydrology — yield from alternative intakes.

The engineering studies are largely complete and have shown that the problems of constructing the banks of the lakes are amenable to conventional earth moving techniques with the most effective plant being a combination of dragline and tracked hydraulic excavators.

The initial biological and chemical studies have shown that it is possible to treat the stored water to produce a potable supply



The Somerset levels and moors

Model scale treatment plant is to be installed in summer 1985 to evaluate the costs of the most economic treatment processes.

The hydrological studies have been bedevilled by the fact that it has been impossible to measure the flow of the River Brue accurately anywhere near the proposed intake points. Only 60% of the catchment is gaugable and in addition the wet fencing requirements are a significant and largely unknown proportion of the summer flows.

Dr Newman was closely questioned about liaison between Wessex Water Authority and the Nature Conservancy Council and was able to assure the audience that the two bodies had been in close contact since the inception of the project and that Wessex had employed a full time conservation officer to ensure that due attention to environmental effects was paid on this and all other schemes.

The closing address was given by Mike Mansell Moullin who expressed a desire for more multi-disciplinary meetings, a view shared by his audience who went home with memories of a full and interesting day held with the co-operation of the weather in ideal surroundings.

Alec Willis

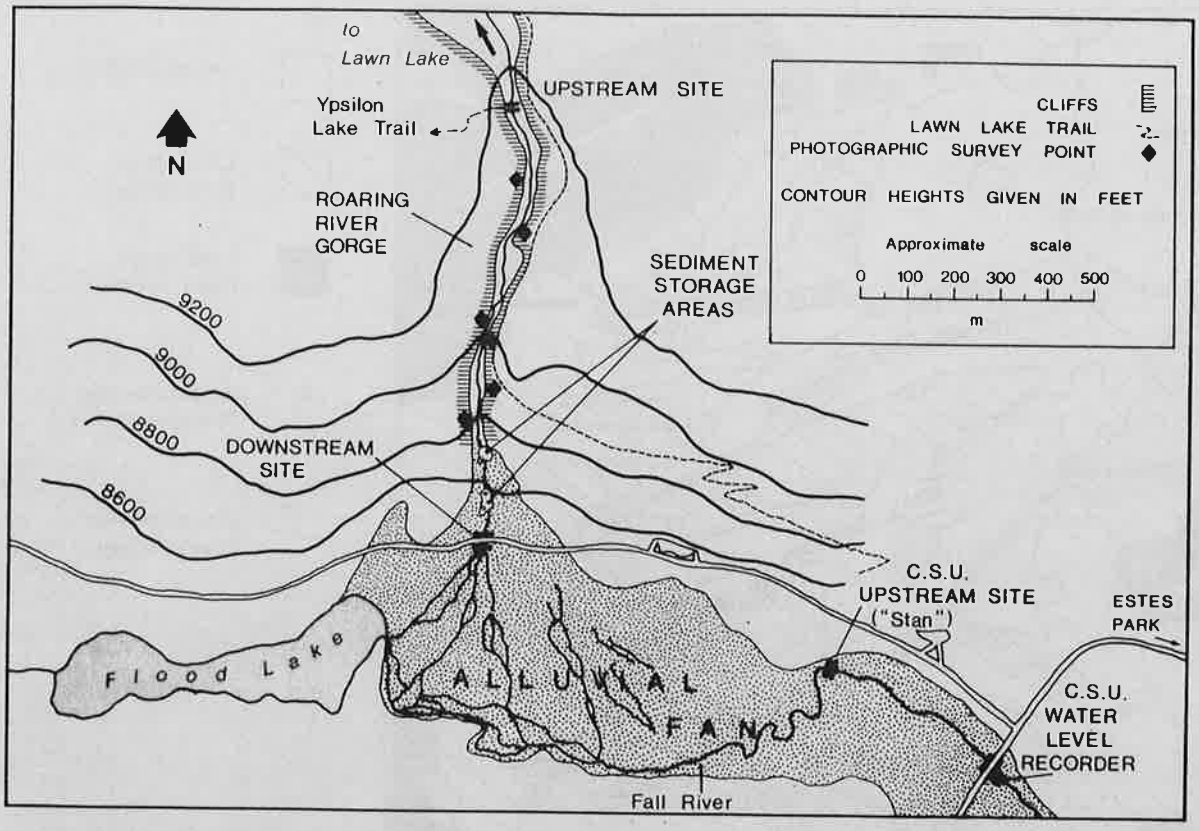
Sediment Transport in a Colorado Mountain River after a Dam Failure

BHS Southern Section Meeting 15 April 1985

In July 1982 the flood wave from the Lawn Lake dam burst in the Rocky Mountain National Park, Colorado, creating a series of alluvial fans and gorges with unstable cliffs along the downstream channel of the Roaring River. The effect of these features on the supply and unsteady transport of sediment in the river in the aftermath of the flood is the subject of a joint project between the IH Unit of Fluvial Geomorphology and Colorado State University, partly funded by N.A.T.O.

James Bathurst (IH) stated that whilst the existing bed load formulae based on standard hydraulic equations are adequate for large piedmont rivers, they greatly over-predict loads in small mountain streams. This is a result of the limited availability of small sediment sizes. The area in Colorado generally has high river flows, and the supply of sediment from the unstable landscape was rapid enough to enable a sediment budget to be assembled in a short field season.

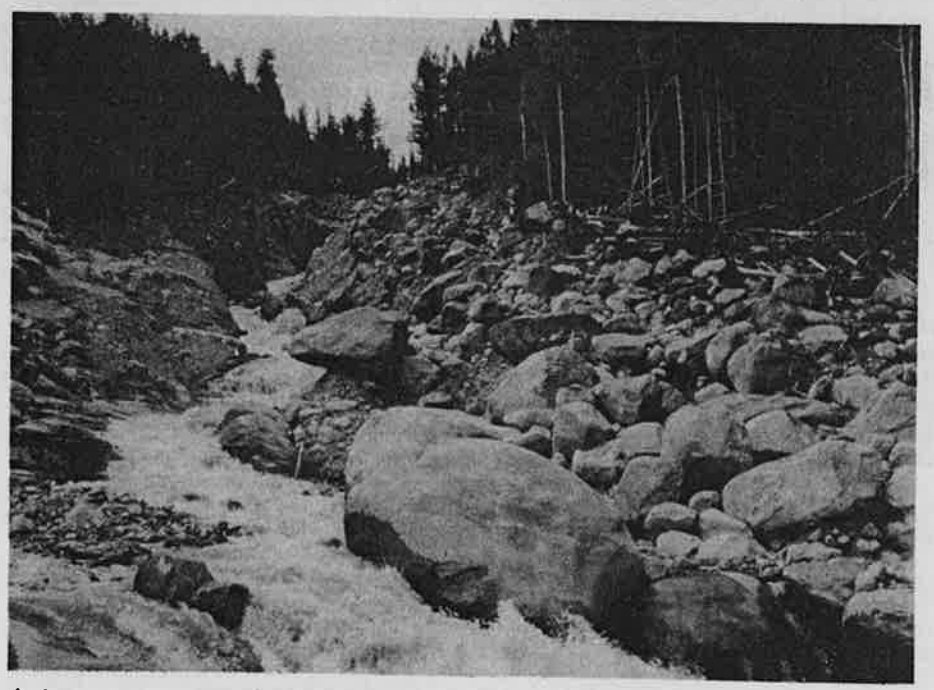
Colin Thorne (Queen Mary College and CSU) showed a TV newsreel of the flood, taken only a few hours after the dam burst. Together with photographs of the resulting erosion still clearly evident two years later, this gave the audience a rare opportunity to view both an extreme flood and its geomorphological effects (so often we can only see the latter). In places the flood wave incised 15-20 metre deep canyons through glacial material to bedrock. An alluvial fan was deposited covering 15 hectares, with boulders deposited high above the original bed level. The speed of the flood wave down the valley averaged only about 5 km/hour as a result of a complex pattern of damming and breaking through the rock and timber debris dams. **Malcolm Newson** (IH) said how unusual it was in geomorphology to have a large event occurring in a short time scale, and that it provided a chance to study the processes of recovery. He noted that it is the 60th anniversary of the Dolgarrog dam failure in North Wales which led to the reservoir



Sketch map of the study area

safety legislation in this country. Although that reservoir was of a similar size to the Lawn Lake, a much greater number of people had been killed. **Graham Leeks** (IH) described how the team had measured the components of the sediment budget of the most spectacular gorge. This had necessitated the development of a portable sediment laboratory, able to deal with a wide range of sediment sizes. The storage of sediment within in-channel shoals and the input of material from the unstable cliffs were measured by a range of techniques including stereo photography, optical range-finders and traditional abney levels. Channel sediment availability was assessed by measuring sizes with a pebbleometer, whilst its rate of movement was measured using a modified Helley-Smith sampler.

In addition to simply measuring the movement and storages of sediment, the team decided to speed up the natural processes further by creating an artificial cliff collapse. The team's big bang was achieved by blowing up a cliff face with home-made explosives. The source of the technical knowledge to achieve this, and how permission was obtained to carry this out in a National Park were the subject of some speculations in the bar after the meeting! The result of the cliff collapse was a very quick suspended sediment response, with bed load in the next flood about twice that at equivalent discharges before.



A view of the downstream end of the gorge "Hydrologist's Gulch"

Results: The results of the field season illustrated a number of points. Erosion of cliff faces during rainstorms contributed a greater quantity of sediment than undercutting by snowmelt (however this conclusion was based on a short field season and the first thaw of winter may flush out a great deal of sediment). The maximum size of sediment moved was a function of the flow, and the larger material did not move, confirming the limited availability argument.

The discussion covered a wide range of topics of which the following are only samples. **Peter Ackers** congratulated the team on their achievements, although he felt they had been somewhat unfair in their description of sediment transport equations since modern formulae do take account of the different size fractions present. James Bathurst agreed with this correction and explained that they are looking at how transport is affected by the supply of different fractions during a storm, and the importance of bed forms and sediment packing. **Ian Reid** (Birkbeck) asked about problems of "bedding in" the bedload sampler. Malcolm Newson described his method of "gardening" the stream channel some time before taking measurements to provide a flat site for the sampler. Malcolm was also selected by the team to go into the water as ballast to help hold the sampler down in very turbulent conditions! **Bruce Atkinson** (QMC) noted that the field site was an unsteady, untypical area, and asked how the results could be applied to "normal" systems. James Bathurst said that while it was a case study and the results could not be applied elsewhere, it helps us to understand the supply and transport processes operating.

Mark Robinson (BHS Southern Section Committee/IH) thanked all the speakers on a very well illustrated and thought provoking presentation, and wished them well on their return visit to Colorado this June. Doubtless we shall read about that in the next issue.

Mark Robinson

The Future of UK Hydrometric Networks

BHS Midlands Section Meeting
17 April 1985

This meeting on a subject of national interest was chaired by Richard Wood (STWA) and attracted 60 hydrologists from many parts of the country. The increasing financial pressures within the water industry are leading to ever closer scrutiny being given to, and justification required for, the money and manpower allocated to hydrometric data collection. Three speakers were invited to speculate on the future of hydrometry. Particular emphasis was given to the collection of river flow data.

Mike Lowing (IH) opened the meeting by describing some of the ideas behind national network design. The objective had been the development of techniques to determine the minimum number of sites required to estimate given hydrological characteristics to an "acceptable accuracy". Two particular problems had been identified: first a dense network was needed to quantify the variability of estimated quantities, and second was the validity of transferring results.

IH had been involved with the scheme to rationalise the daily raingauge network in Wessex, and the Met. Office had thought that this work was transferrable to the rest of the UK. Mike was unenthusiastic about the application of network design techniques to river flow gauges, the reason being that there are so many data features of interest in any given flow record. Monthly flow data might be adequately estimated, but in general the techniques had become devalued because of doubts about the accuracy of the estimated data. The inescapable conclusion was that a pragmatic approach should be adopted for network design.

Moving on to meeting future national and international river flow data requirements, IH are now the custodians of the National Surface Water Archive (see *Circulation* No. 6). There will be the continued collation, archiving and publication of daily mean flow data from a number of key gauging station sites near to sea, major confluences, and for harmonised monitoring. Selected events from representative catchments for rainfall runoff modelling will be stored, as will updated records of flood peak flows from gauging sites with more than 10 years of record. Naturalised daily data will also be held where it is available and of sufficiently good quality. In general, IH are looking for as much daily data of any kind as can be obtained, and then decide whether or not it is worth keeping.

The archiving of long continuous records is important for assessing accurately the basic statistics of a flow record — WMO have estimated 30 to 40 years of record are needed to assess the mean flow in a predominately wet climate, whilst nearer 70 years are needed in a variable climate! The average station length in the UK from nearly 17,000 station years is now 17 years, whereas in West Germany, the figure is nearer 25 years from 40,000 station years. The archive will service as best it can a range of legal, research and education requirements, whilst its existence will hopefully provide at least a moral excuse for keeping the nation's key flow gauging stations operational.

The future hopes and fears for education and academic research were given in an entertaining presentation by **Ted Hollis** (University College, London). After some personal thoughts about the narrow definition taken of hydrometric data — why not include consumption information or sewer flows — and the sombre view taken over gauging station closures, spirits were lifted by a review of some recent positive developments. A greater emphasis on teaching through project work had been facilitated by improved collation and archiving of data by microfilming and digitization. Access to data for teaching had been vastly improved by the increased availability of computing resources. Indeed, Ted looks forward to the day when he can readily access hydrographs of his choice from Water Authority databases!

On the debit side, the restructuring and rationalisation of hydrometric networks appeared not to have been approached scientifically, and had resulted in the truncation of historic runs of data. There had been a gradual reduction in published data via Annual Reports and Yearbooks: they were now all glossy photos and pap! The costs of obtaining centralised computerised data had soared — the Met. Office charges were now punitive for universities who have less cash to spend themselves. (In discussion, the basis for these charges was questioned, but there was no-one from the Met. Office at the meeting to comment!).

Basic hydrometric data appeared to have a diminishing role in academic research. Catchment research is no longer fashionable (there are only 12 hydrological studies in 321 currently funded NERC studies) and only 15 out of 142 published papers listed in the latest IH Research Report are concerned with catchment processes. To facilitate research, a plea was made to co-ordinate the data collection activities of the various government departments responsible for hydrometeorology.

So what of the future; how might privatisation affect data collection? Would data be a service which has to be sold thereby becoming a profit centre? In spite of those uncertainties, the prospects for teaching were viewed with some optimism. Surely things could not reach the position in recently visited Tunisia where data collection had ceased altogether in 1956, or could they . . . ?!

In describing the review of the gauging station network begun by NWA in 1979, **Phil Johnson** (NWA) reminded us that there are now no mandatory requirements upon Water Authorities to maintain hydrometric networks. The review was therefore based solely on internal requirements. Put simply, the method of review was to allocate for each gauge a data value (either essential, beneficial or speculative) over a range of network data uses. This pragmatic appraisal resulted in the closure of 8 gauges from a total of 50, and a saving of some £56,000 per annum in staff time. Further time had been saved by reviewing raingauge and borehole network reading routines, and now more than half of all current field staff time was spent on more professionally rewarding sewerage investigations.

Whilst stating that little of the methodology of network design had filtered through to the gauge selection decision, Phil produced an illuminating example of how the doubts about the accuracy of estimated flows might be translated through to something more meaningful in engineering terms. Using the data from a distant gauge at Bywell, the dam height at Kielder was predicted to range from 44 to 54 metres for a given guaranteed yield. (It is in fact close to 50 metres!)

The difficulties of being able to justify expenditure on data collection were raised in discussion; maybe part of the problem is being able to communicate clearly to senior management the benefits accruing, and the consequences for failing to collect the data. **Peter Walsh** (NWWA) reported the efforts of the USGS to identify where reductions in accuracy were acceptable, rather than adopting one of two extremes — either outright closure or doing the best you can — which seems to be the approach in the UK. Much of the discussion homed in on the major conclusion of the meeting: in Mike Lowing's phrase — "Pragmatism Rules"! Amid the general apprehension about what the future may hold for hydrometric data collection, speakers and discussors stuck to the point — quite an achievement since areas like data processing and instrumentation might have redirected the main thrust of the meeting.

W.T. Bradford

CONTINUING EDUCATION COURSES FOR CIVIL ENGINEERS

Before any candidate undertakes the first part of the Professional Examination he or she must have spent the equivalent of at least 15 days of at least 6 hours in continuing education or off the job training.

Meetings arranged by the British Hydrological Society can count towards these 15 days.

Where approval has been granted as qualifying towards continuing education or after jobs training the details will be included on the notes for the meeting.

George Hornberger on "Catchment Modelling"

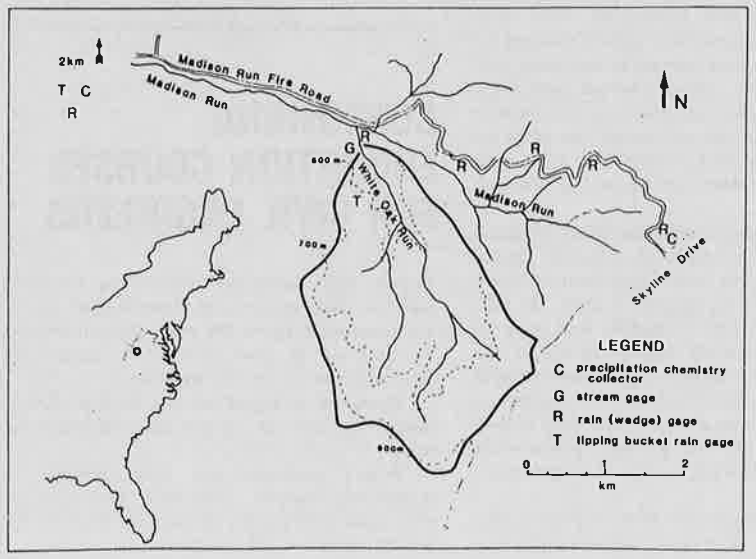
BHS Southern Section Meeting
3 June 1985

If one were looking for the classic example of a good turbulent love/hate relationship, an excellent choice would be hydrology's chronically problematic involvement with the modelling of catchment response. The prospect of a happy marriage between model complexity that is realistic and model simplicity that is tractable has kept many researchers and their computers hard at work for longer than most would probably like to admit. Lest anyone's interest in the subject had begun to wane though, "acid rain" and the need for a hydrological foundation on which to base our understanding of the chemical processes that result from "acid rain" has added a new impetus to the modelling of catchment response. Professor George Hornberger addressed the BHS Southern section on June 3rd about his recent work on this subject in conjunction with the Shenandoah Waters Acidification Study. His thorough presentation succeeded in raising many of the issues pertinent to conceptual modelling, as well as a few eyebrows, since some of his findings challenged the conventional wisdom on the subject.

Professor Hornberger heads a research team at the University of Virginia which was commissioned by the United States National Park Service in 1979 to investigate the potential effects of acidic atmospheric deposition, especially those related to sulphur, on the Shenandoah Valley, a largely unspoiled area of remarkable beauty in Virginia. He has been analyzing the study's data during a sabbatical at the University of Lancaster, and his talk focussed on the hydrological aspects of that work. He explained that the University of Virginia team's research began with process studies to determine the dominant features of hydrological response in the region's upland catchments which a conceptual model would have to reproduce. The fieldwork was done on White Oak Run (WOR), a steep, 5 sq. km. catchment chosen to be representative of the area because of its thin autochtonous soils covered almost entirely by mature deciduous forest (see below).

The process studies centred upon a throughflow trench in the catchment which isolated three separate flow pathways, an overland route through the litter layer, a root zone pathway in soil down to 0.4 m, and a subsoil pathway extending from 0.4 m down to "bedrock" at between 0.5 m and 1.25 m depth. Unfortunately, the throughflow study was delayed by an extended drought which commenced immediately upon completion of the throughflow trench. (This was attributed to Murphy's Law, the colonial corollary to Sod's Law.) Eventually it did rain again.

Overland/litter flow was found to be minimal. The root zone responded to large storms in less than an hour with flows of up to 50 mm/hr. The subsoil, however, responded with flows of over 1000 mm/hr, also in under an hour, and with macropore flow much in evidence. The nature of the catchment's response was further quantified by chemical studies and a series of observation wells. The chemistry indicated that most of the stream discharge was groundwater displaced by infiltrating precipitation (i.e. piston flow). The strength of the link between groundwater and streamflow was illustrated by the virtually simultaneous fluctuations of the watertable and streamflow.



With knowledge of these catchment characteristics, a mathematical model was developed using an extension of Beven and Kirkby's TOPMODEL. This model predicts the variable saturated contributing area from catchment topography and soil characteristics. With 13 parameters, however, the model is rather "overparameterized" for the data available, making it extremely difficult to determine the appropriate parameter values with much certainty. Professor Hornberger explained that a simpler model may have adequately described the hydrology, and avoided parameterization problems, but the ultimate goal of the study was to investigate the catchment's chemistry. Since it was not known *a priori* which hydrological pathways and storages would be most significant chemically, it was important to incorporate as much hydrological detail as possible. A processes' relative lack of influence on the hydrograph was not adequate justification for omission. Unfortunately, this leaves the modeller with the difficult problem of how to scientifically justify the numerous hypotheses incorporated in a complex model on the basis of observations made in the field. The remainder of the talk, as well as the discussion, focussed on this problem.

Professor Hornberger's approach to the problem began by dividing the WOR data into two sets, one for optimizing the model's parameters, and the other to validate the model's performance. The "optimization" process goes right to the heart of conceptual modelling's difficulties, and even choosing the optimal optimization technique has proved as difficult as choosing the optimal parameters for a complex model. As a result, the WOR model was investigated using a variety of optimization techniques. To begin with, no less than eight different objective functions were used, ranging from the sum of squared errors (SSE) to a maximum likelihood function suggested by Sorooshian and Dracup to improve the objective function's "response surface". These objective functions were applied in two very different calibration procedures, optimization based on the Rosenbrock Algorithm, and a regionalized sensitivity analysis (RSA). The latter technique was developed by Hornberger and Spear to use Monte Carlo simulation to determine which parameters the model was sensitive to, and what ranges of parameter values yielded reasonable results.

"Reasonable" results are a far cry from optimal, but the results of the Rosenbrock optimization on the full 13 parameter TOPMODEL showed that optimatization alone was incapable of uniquely determining parameter values. Five Rosenbrock optimizations using the SSE as the objective function gave five "optimal" (sic) parameter sets which bore precious little resemblance to each other. A similar series of tests using the maximum likelihood objective function designed specifically to mitigate such problems failed to yield any significant improvement in the convergence of the parameter sets. The RSA fared somewhat better. Running the model 330 times using parameters selected at random showed that the model was sensitive to only four or five of the 13 parameters. Unfortunately, and rather surprisingly though, just which four or five parameters were most

important depended to some extent on which objective function was chosen. Nonetheless, three of the parameters proved to be significant for most of the objective functions and corresponded to processes deemed to be significant in the field studies.

On the basis of the RSA and the results of the process studies, another attempt was made at Rosenbrock optimization, but this time with the values of nine of the less significant parameters fixed in the middle of their range and only four parameters being optimized, (roughly speaking the soil's field capacity, a flow recession factor, riparian area and streamflow velocity). In these optimizations, the parameter values converged quite well, but regrettably, the "optimum" had an SSE that was 25% worse than was achieved by optimizing the full 13 parameter model. This result indicates that there can be a subtle relationship between "sensitive" and "insensitive" parameters which calls into question the generally received notion that fixing less sensitive parameters is a good way to reduce the dimensionality of a complex model. In fact, a far better model resulted in this particular case by simply exercising eight parameters (and the processes they ostensibly represent) from the model. Not only was the Rosenbrock Algorithm able to consistently identify an optimal parameter set, but the SSE from this drastically slimmed down version of the model was also only 8% worse than that of the full 13 parameter model.

After taking his audience very carefully through the difficult business of calibrating the model, Professor Hornberger turned briefly to the validation of the calibrated model. Model performance with the data reserved for validation proved disappointing. There is good reason, though, to believe that this has more to do with some problems in the field data, rather than with the model itself. To be specific, the validation period included a storm about an order of magnitude larger than any event seen in the calibration period. Again, one must cite the influence of either Murphy or Sod, depending on whether one customarily takes one's beer refreshingly cold or just warm.

Professor Hornberger concluded his talk by posing again the dilemma, recognized several years ago by Beck, which confronts the modeller. It is only possible to calibrate with confidence a simple model that will probably fail to incude important hydrological processes, while any model complicated enough to model the complexity of real processes seems doomed to never having its parameters adequately identified. To this the speaker added his own admonition, based on the results of the WOR study, that arbitrarily fixing apparently insensitive parameters in complex models could not always be considered a satisfactory shortcut to simplicity.

A lively discussion session ensued, and although most of the questions sought clarifications of certain technical points, there was also an underlying interest throughout the discussion in just what the links were between processes identified in the field, and the conceptual model which results. Professor Hornberger remained firm about the importance of process oriented field studies, while at the same time insisting that measurements made in the field could not be used as parameter values for conceptual models. This implies, one must assume, that it is unrealistic to hope that conceptual models could be fitted to ungauged catchments on the basis of field measurements.

As a researcher who can well be pleased with what he has accomplished in catchment modelling. Professor Hornberger was nonetheless quite frank in stating that fresh approaches to catchment modelling were needed, though he also felt that there was some hope that chemical data might help by providing more much needed constraint upon conceptual models. Thus, even after years of hydrology's love/hate relationship with catchment modelling, there is still ample scope for creative new ideas about how to identify hydrological processes in the field and describe them in a scientifically verifiable form.

Kevin Bishop

NEWS FROM MEMBERS

FROM AUSTRALIA

The 1985 Hydrology and Water Resources Symposium of the Institution of Engineers Australia was held between 14-16 May in Sydney and attended by two BHS members, **Frank Law** (Binnie & Partner Pty Ltd., Melbourne) and **Jim Davies** (Dept of Agriculture, Perth). This annual symposium attracted a 250 strong audience and 46 papers were presented, including a paper by the writers using the FLOUT model for a flood study in Western Australia. **Peter Cloke** presented a paper comparing the success of river flow data collection in Australia and Indonesia with his own for the operators of the OK Tedi mine in PNG. OK Tedi data were of equal if not superior quality when comparing maximum rated flow to maximum recorded flow. We will leave Peter to report to BHS on his work when he fulfills his promise to join the Society!

Regarding low flows a paper by **I. Cordery** showed that the several existing definitions of drought tend to rank historic events differently so that more than one definition should be used in practice. In a significant paper, **R. Srikanthan** and **T.A. McMahon** succeeded in reconciling a conflicting frequency analysis of non-overlapping flow sequences longer than 12 months duration with an analytical procedure. This was achieved using the compromise plotting position of Con Cunnane ($F = {}^{i-0.4}/_{N+0.2}$) rather than the earlier, biased formula $F = {}^{i}/_{N+1}$. An empirical relation was then derived by simulation between non-overlapping and overlapping sums.

The estimation of parameters k and m for the runoff-routing model RORB developed by Profs **E.M. Laurenson,** and **R.G. Mein** (Monash University) was the subject of several papers. A maximum likelihood method derived by **B.C. Bates** and **L.R. Townley** was well received in this respect.

On a lighter note members will be interested to hear of the inaugural Hydrologic Games held one evening in the form of a Hydrology Mastermind complete with arm chair and spotlight. Questions to a chosen representative for each state ranged from "Who invented the unit hydrograph?" (Sharman) to the old chestnut "What is the probability of the 100 years flood occurring at least once in a 100 year period?" (0.63). It was reported afterwards that about 500 questions had been devised and only 100 or so needed on the night. The tug-of-war which followed was conducted on a five person team per State basis. From these events Queensland has the brains and Victoria the muscle.

Following the Symposium a one day Workshop was held to discuss the revision presently taking place of the publication Australian *Rainfall and Runoff* (1977). The revised volume is scheduled to appear late next year as a "state of the art" publication, recommending the best procedures in current use – a rather different approach to that taken in the production of FSR. For example, for peak flow estimation it is recognised that no single method is applicable to the whole of Australia, so that several published applications of the rational method, the regional flood frequency method and the runoff-routing methods – each based on local data, will be included. The document is being drafted at University of New South Wales under Associate Professor **David Pilgrim**; it involves considerable voluntary effort as well as professional and commercial sponsorship. The Bureau of Meterology has revised thoroughly its nationwide rainfall-intensity-duration-frequency figures and added PMP values.

In summary, the Australian hydrology and water resources scene is an active and optimistic one. To take flood hydrology as an example there is perhaps a five to ten year lag behind the UK in terms of published manuals (FSR cf. ARR) but a determination to recommend methods which will be used readily by the profession. Given the size of the continent this is no mean feat. Proceedings of the 1985 symposium are available as a 214-page volume from the Institution's agents, E.A. Books, P.O. Box 299, St. Leonards, NSW 2065 for a price of Australian $34.50 including sea postage.

J.R. Davies

DATA PROCESSING AND ARCHIVING

Yorkshire Water are uprating their recording raingauge network, writes **Margaret Fallon** in terms of both numbers and the standard of gauges. Earlier this year, 27 Didcot tipping bucket raingauges and 30 Goldcrest loggers were purchased, and eight of each have been installed. Data are being stored on floppy discs on a Commodore "PET" 8032 Microcomputer, pending development of a full computer processing and archiving system.

A small number of Goldcrest river level loggers have also been purchased, and are being evaluated. Setting up of YW's first automatic climate station is also in hand.

YW's Rivers Division has produced a document outlining a strategy for a Division Telemetry Scheme. If adopted, this would provide telemetry for both data archiving and flood forecasting functions. These functions have historically been carried out by different departments, using separate networks of interrogable devices. The next step will be the preparation of a user specification for the proposed system.

A program of regular RAFT gauging is being carried out – checking against Crump and Flat V gauging weirs. It is hoped that, by the end of the year, it will be possible to decide whether or not to proceed any further with this technique.

The data processing and development group at Thames Water have developed a data processing package for Sarasota loggers. The package is mounted on the department's Hewlett Packard 9845b. There are now six sites at which Sarasota loggers are installed. These include both of the authority's electromagnetic sites and four of the ultra-sonic sites. The processing system reads the loggers and stores the 15 minute readings of level and flow on HP discs. Subsequent editing of the data is possible. This system is now the operational means of recording data at these sites.

The Thames group have also been reviewing the available data loggers for recording river levels. A number have been borrowed for testing. All these loggers have been read successfully using the Hewlett Packard. A preliminary report has been written, and it recommends the purchase of a number of loggers from two manufacturers. A further review will be carried out after a test period.

The authority's telemetry computer is still being upgraded to allow micros to access rainfall, river levels and radar data. At present rainfall and river level data can be accessed via one micro, but radar data are still unavailable.

From Wessex WA, our BHS correspondent, **Alec Willis** tells us that the Water Research Centre have appointed a member of staff to work exclusively on the Authority's hydrometric instrumentation Evaluation and Demonstration Facility at Little Canford. Wessex have also purchased an IBM-compatible personal computer to record levels from the instruments and compare this data with the reference level. It is expected that the first test of pressure transducers will start in November.

The data collection and retrieval side of the water management EDF is behaving satisfactorily but the alarm dialout part of the package is not yet fully accepted and work is in hand to resolve this problem.

Wessex Water Authority has also designed an insert flume for measuring flow in unsurcharged swers. These have humped rectangular throats with a semicircular front and rear allowing the flume to seat neatly in a half-round pipe section. The leading edge of the flume is chamfered to ensure no rag collects. The flume has been designed so that the throat sits neatly in the downstream pipe leaving only the approach visible in the manhole chamber. Calibration checks using a current meter have revealed an acceptable level of accuracy but a calibration rig is being built to test the accuracy volumetrically. The cost is £2-300. The Authority also uses fibre-glass flat-vee weirs extensively for river monitoring at a cost of £100-150 per metre width.

Somerset division installed six TG-1150 river level recorders during March, bringing the total up to eight. They are being run in parallel with existing punched tape recorders for three months, with the early indications being that they are a more than adequate replacement. Data is being retrieved on demand (normally two or three times a week) using a program knocked up in-house to drive a Racal autodial modem. Three days' data from eight sites can be retrieved and printed in the accepted monthly summary form in 20 minutes. Although the six D size alkaline batteries normally last a year, one site developed a fault which meant that the batteries were flattened in six months. The recorder was taken from site at 6 a.m., repaired free of charge under warranty, and re-installed by 5 p.m.!

The Authority will be sending all raw rainfall data to the Meteorological Office by magnetic tape with effect from July's data. This has the benefit to Wessex that the data is available online as soon as it has been punched, while the Met. Office has no punching to do at all. Gordon Hobbs (Bath 313500) would be interested to hear from anyone who has looked at the Met. Office rainfall quality control system.

The Bath Avon division is now running a Goldcrest rainfall data system on behalf of the Authority. Both loggers and translation facility have proved satisfactory and we will probably use the Goldcrest system (sold by both Casella and Munro) to supplant autographic raingauges for the foreseeable future.

RESOURCES

Cathy Glenny of Thames tells us that Phase 1 (feasibility study) of the Enfield-Haringey Artificial Recharge Scheme is proceeding. Pumping tests and geophysical logging are being carried out on recently constructed purpose-built production and observation boreholes. Tests on potentially useful adited wells are also being planned. Several new sites are to be constructed over the next two years.

The feasibility of on-site ultra-violet disinfection is to be assessed at two existing artificial recharge sites over the next year. If acceptable this would provide a cheaper method of disinfection than conventional chlorination.

From the South West, we have a note from **Neil Whiter** that "The healthy state of reservoir storage in the South West this summer has given the Authority the chance to learn the lessons of the past three dry years. It has also given management the opportunity to implement the long delayed Authority Review. It is hoped that the hydrological staff will soon be up to its full complement of two."

GROUNDWATER

The British Geological Survey, under contract to Thames Water, are in the process of mapping 300 sq. km. of the Cotswolds. The area covered is the southern half of the 1:50,000 New Series Geological Sheet 235. The work is part of an extensive programme of investigation of the groundwater resources of the Cotswolds limestones.

Several new observation boreholes are to be constructed in South London and North-east London over the next year. These will provide additional hydrogeological data.

A survey of the groundwater chemistry of the London Basin will commence this month. This will provide a baseline against which to compare any future changes resulting from artificial recharge.

EDUCATIONAL

The Lincolnshire division of Anglia Water, like many others, has had lots of requests from schools for data for use in project work. Their way of dealing with this matter has been to generate computer listings of rainfall, flow and stage, suitable to run on a BBC Micro, which they have now handed over to the Lincolnshire Education Department's Computer Centre (contact: John East).

BHS MEMBERSHIP

On 1st July 1985, BHS had 410 members. As well as the large number of late renewals which did not always find their way into the Directory, we welcome:

I.N. VAYE – *Republic Liberia – Hydrologist*
P.E. KNEALE (Miss) – *Leeds University – Lecturer*
D.R. BILLINGTON – *Malaysia – Forest Dept.*

MEMBERS ON THE MOVE

Steve Wiltshire has left IH and has moved further down the Thames to Marlow to join Geomorphological Services Ltd., a firm of Earth Science consultants.

Keith Beven is also leaving IH in September to take up a lectureship at Lancaster University in engineering hydrology (some of his colleagues have been heard to ask whether he'd like to learn some before he goes . . .)

Sara Holt of Anglia Water Authority, previously a hydrologist based in Oundle, has moved to become Area Operations Engineer (Water Supply) in Bedford.

The Colchester Division of AWA has moved offices to:

33 Sheepen Road,
Colchester,
Essex CO3 3LB
Tel: 0206 69171

Please note that the whole division is now here, including the hydrologists from Chelmsford.

NEW DEFINITIONS OF YIELDS OF WATER RESOURCES

During severe droughts such as those of 1976 and 1984 it was evident that a revised definition of yields of water resources in the Welsh Water Authority was required, taking into account operational management of the sources. The yields had previously been derived using traditional hydrological methods, mostly using 2% design droughts; they assume that a reservoir starts full and that it just empties during the drought.

The new approach takes account of, in association with control curves, the following facts that occur in situations when the sources are severely tested:—

(a) variations in demand on the source e.g. increased demands early on and cut-backs as the drought develops.
(b) reductions in compensation flow from reservoirs, taking into account time taken to react to the weather and to go through the necessary administrative procedures.
(c) the amount by which residual flows in rivers can be reduced, building on information gained on river conditions in 1976 and 1984.
(d) the requirements of the water supply engineers to guard against a drought which may continue well into the autumn. As it happens both the 1976 and 1984 droughts ended in September but the new criteria allow for no significant rain until October or November.

The more realistic yields will be useful in demonstrating how a source or group of sources should be managed optimally during a severe drought.

Mike Featherstone,
Logan Jack

Thesis

Damian Lawler has sent an abstract of his recently accepted PhD thesis, submitted to Birmingham University.

Processes of river bank erosion: the River Ilston, South Wales, U.K. Research focused on the rates, patterns and mechanisms of bank retreat over a 2¼ year period. The small Ilston catchment was instrumented with three gauging stations and a meteorological station to provide local and continuous streamflow and temperature data. Bank retreat was monitored at six sites, using 230 erosion pins arranged in dense grid networks in order to define spatial variability in material removal. More than 3,800 erosion pin measurements over the monitoring period gave average rates of erosion of 0.02–0.31 m a^{-1}. Detailed proportional-circle erosion maps and simple statistical analysis of spatial patterns showed that loci of maximum erosion varied seasonally but, when patterns were integrated over the whole study period, most banks seemed to be undergoing parallel retreat.

Strong seasonality in erosion was observed, with most material removal taking place between December and April. This was the period of most intense freeze–thaw action and a clear vertical zonation in bank frost action was mapped. Briefly, the upper parts were disrupted by in-situ freezing, while needle ice development was maximised on the lower slopes. This zonation was related to the vertical distribution of temperature (measured autographically at selected critical periods), moisture availability and bank material grain-size, bulk density and porosity characteristics. On-site measurements and other workers' data showed that needle ice growth rates averaged 1–3 mm per hour of freezing. Detailed evaluation of the sediment incorporated in needle ice samples (< 5 kg m^{-2} of bank) suggested that the directly erosive role of frost processes was less important than indirect, or preparational effects. Substantial fluvial erosion of banks occurred only when the material had been preconditioned by frost activity, and this was often marked by the formation of erosional notches at various heights on the bank (but never above the vertical limit of previous needle ice growth) which demonstrated that a *range* of flows was capable of effecting significant morphological change.

Exploratory multiple regression analyses (based on up to 37 independent variables representing aspects of air and ground frost intensity, rainfall magnitude/frequency, antecedent wetness and streamflow characteristics) revealed that air frost indices explained most of the temporal variation in erosion at most sites. "Split-data" tests showed how simple equations developed for the first part of the study period could be used to satisfactorily predict bank erosion rates in the second half (and vice-versa). The penultimate, synthesis, chapter showed that the study period could not be considered climatologically unusual in any way. In addition, the "existence domain" of needle ice at the global scale was defined as a linear envelope by plotting all suitably precise published sightings of the phenomenon with respect to altitude and latitude. Finally, it was tentatively argued that all other factors being equal, subaerial activity may be more dominant in smaller-scale systems, with fluvial forces and mass failure processes becoming more important in progressively larger rivers.

FLOOD STUDIES REPORT GROWTH CURVE

Readers may recall that *Circulation* No. 3 reported on the Hosking/Wallis/Wood findings about the FSR methods of regional frequency curve derivation, together with a statement from IH by John Sutcliffe. Responding to more recent enquiries from BHS members, I can confirm that the recommendation to FSR users is still "the mixture as before".

I understand that the differences reported in the earlier Newsletter are rooted in different interpretations of some details of the original FSR procedure. The close scrutiny prompted by that debate revealed shortcomings in graphically based procedures of frequency curve derivations which in turn highlight the desirability of objective parameter estimation procedures and combining data from homogeneous subsets.

Until the current reappraisal with the extended data set has been completed, FSR users should continue to estimate design floods using Flood Studies Supplementary Report No. 14.*

Editor

*"Review of regional growth curves" *Flood Studies Supplementary Report No. 14* (August 1983) is available from the Institute of Hydrology, Wallingford, OX10 8BB.

BOOKS

Unesco publications for the International Hydrological Programme

Unesco considers one of its successes to be its water resources programme, mainly carried out through the International Hydrological Programme. IHP certainly has the laudable objective of helping to solve the water related problems of the world. The tools used are a scientific programme for the consolidation of hydrological knowledge (that is writing books and holding conferences), and an education programme to transfer knowledge and skills.

Is the objective met – is there value for money and effort? Probably not. The excellent books written do not reach their intended audience in developing countries, despite the subsidised prices. The training courses have a good reputation but are very infrequent and have little follow up. Conference attendees are from the developed countries, with a few third world academics and no practitioners.

Who benefits from IHP? The academics and others who serve on IHP working parties and exchange ideas with co-workers, make useful contacts and improve their CV's. The lucky few who attend training courses or are subsidised to attend conferences benefit. And, to come to the point of this review, anyone who gets the excellent, heavily subsidised, technical publications that Unesco produces.

There are three series of publications. Studies and Reports in Hydrology (S & RH) is the flagship series of books which would grace any commercial publisher's catalogue. Technical Papers in Hydrology (TPH) are a miscellaneous collection, shorter and cheaper than S & RH, in the second division. Technical Documents in Hydrology (TDH) are short and free, and of variable quality. Recent issues in S & RH and TDH are reviewed below.

S & RH and TPH are available from HMSO (telephone sales: 01-622 3316). They are also available slightly cheaper from Unesco, PUB/C, 7 Place de Fontenoy, 75700 Paris, if payment is in French Francs. Catalogues and TDH are available on request from Unesco, Division of Water Sciences, 7 Place de Fontenoy, 75700 Paris.

David Lerner

Regulated River Basins: A Review of Hydrological Aspects for Operational Management by an IHP Working Group, edited by T. Kitson. TDH, Unesco, Paris, 1984. Free.

In addition to the studies on hydrological research and education undertaken by the United Nations Educational, Scientific and Cultural Organization (Unesco) during the past two decades, the International Hydrological Programme (IHP) has – especially since the United Nations Water Conference in 1977 – devoted a significant effort to the multi-disciplinary application of science and education to the practical planning and management of water resources for economic and social purposes.

The present valuable document reports on a study of the principles of the operational management of partly regulated river channels and on seven case studies covering ranges of geographical and climatic environments, of catchment size and hydrological conditions, and of stages of development.

The first part, of about fifty pages, is an elementary textbook of hydrology, of river-regulation problems, statistics and management, of planning and design (including economic and financial, legal and institutional) considerations, and of decision theory applied to operation; followed by a page of 9 recommendations directed partly at Unesco, partly at the scientific research community and partly at the practitioner and his local and national employers. A 2-page list of references, though good, is too short.

The second part is the Appendix with about sixty pages of information in the form of multi-disciplinary case studies which have not before been brought together in such a concise and instructive form. They range from the Rio Grande (USA and Mexico) via the Severn (UK), Sao Francisco (Brazil), Koros (Hungary and Romania), Lot (France) and Volga and Syrdarya (USSR) to the Jordan (Israel, Jordan, Lebanon and Syria).

Though far from complete, the document is a "must" for students of applied hydrology and water-resource management.

P.O. Wolf

Methods of Hydrological Computations for Water Projects A contribution to the International Hydrological Programme S & RH 38, Unesco, Paris, 1982. 65 ff.

Unesco has for twenty years had special programmes of research, development and education contributing to improvements in hydrological science and engineering. In 1982, it published this guide to the hydrological analyses and computations which, about five years ago, were considered necessary in the planning, design and operation of (mostly surface) water-resource projects.

This is a useful book which first lists, and often provides outlines of, all major hydrological techniques known to the ten members of the Unesco working group responsible, and secondly provides quite lengthy, though not complete, bibliographies of works containing further details. Together, all publications mentioned would form a useful practical library for a one-year post-graduate course in engineering hydrology.

For an experienced hydrologist this publication provides a helpful check-list of obvious points to consider in planning and operation. To the intelligent beginner it is a broad guide to many publications, most of them reliable.

P.O. Wolf

Hydro-Environmental Indices: A Review and Evaluation of their Use in the Assessment of the Environmental Impacts of Water Projects by an IHP Working Group. TDH, Unesco, Paris, 1984. Free.

While water projects may function correctly in an engineering sense, some may have undesirable indirect effects. The undesirable effects occur due to the inadequate assessment of the environmental system during the planning and design stages. During recent decades there has been a movement to examine and evaluate the effects of water projects on the physical, biological, social and financial resources of a region in order to achieve the social aims of its people.

This report considers the definition and use of hydro-environmental indices in environmental impact studies. Twelve case studies are examined. These illustrate the negative aspects of omitting a thorough environmental study before implementation of a new project and the benefits that can be gained by using hydro-environmental indices to identify the potential changes which might occur. The case studies also show the gaps in the scientific and technical understanding of environmental systems which prevent an adequate assessment of all environmental impacts and point out the large numbers of people who might be affected by environmental changes.

Bob Crabtree

Groundwater in hard rocks by an IHP Working Group chaired by Ingemar Larsson. S & RH 33, Unesco, Paris, 1984, 228 pages, 100 ff.

Hundreds of millions of people live on lands underlain by hard rocks. For many of the rural populations in Asia, Africa and South America, surface water resources are poor in quality and quantity, or are expensively distant. Wells in hard rocks may provide the only reliable water supply to sustain and improve their way of life, despite the difficulties of finding water, digging wells and low yields. In the past luck has controlled the success rate of drilled and dug wells; with the shortage of money for rural water supply, every dry borehole may mean another village without safe and reliable water. This book is about how to improve the success rate.

The overall message is "Don't drill at random or in the most convenient spot, because too many holes will be dry or give poor quality water". Sophisticated hydrogeological studies using satellite and aerial imagery, geophysics and interpretation of tectonics may seem out of place for rural water supply projects, but they have repeatedly been shown to pay off. The strengths of this book are its guides to practical use of geophysics, remote sensing and aerial photography. The latter section includes examples of stereo air photos with overlays showing interpretation. Another impressive section builds up a map of water development poten-

tial from a series of eight maps of geology, regional fractures, water quality and so on.

But what about water resources? Surely the days are gone when a successful borehole solved all problems. With modern fast and relatively cheap drilling techniques, a region can be peppered with more boreholes than can possibly be supported by recharge; this is especially true if there is to be irrigation which by definition is to make up deficits in rainfall. There is no discussion of aquifer resources or water balances or recharges — a serious omission.

This is an excellent book, especially at the price, bringing together a wealth of theory and practice on groundwater in hard rocks, and how to get it out cheaply.

David Lerner

Guidebook to studies of land subsidence due to ground-water withdrawal. Joseph F. Poland, Editor and Chairman of IHP Working Group, S & RH 40, Unesco, Paris, 1984, 305 pages 85 ff.

Land subsidence is a meeting point of soil mechanics and hydrogeology, and this book reflects the areas of influence of each group of practitioners. Engineering dominates Part I, the manual, with descriptions of field measurement devices and laboratory tests, soil mechanics descriptions of the mechanisms of subsidence, and porous media models for prediction. The case studies comprising the 160 pages of Part II are much more about geology.

The most spectacular cases of subsidence are in thick deposits of recent unconsolidated alluvium, and the book rightly concentrates on these. Most problems and research have been in the USA and Japan, but Mexico City, New Zealand geothermal, Venice and a few others are discussed. Two UK cases of subsidence (Cheshire salt mining and dewatering of the Thames basin) receive only passing mention.

The manual is a good text, though often showing the flaws of multiple authorship; reference lists are comprehensive for material not fully covered. The case histories are disappointing; with an average of 10 pages each, few can do justice to the studies they are taken from. This is a common failing with S & RH books, and a better policy would be fewer, more fully described cases. A second disappointment arises from promises in the book's introduction that it pays "particular attention to measures to control and arrest subsidence". In fact a meagre four pages on the subject do little more than list the possibilities as (a) reduction of pumping (b) artificial recharge on upgradient outcrops (c) recharge through wells.

Joseph Poland is the "grand old Man" of the subject and the book reflects his scientifically sound but pragmatic approach. Overall it is a useful manual for anyone starting out to study land subsidence.

David Lerner

Irrigation Engineering by S.K. Mazumder. Tata McGraw-Hill, New Delhi and Maidenhead. £5.95.

There is a wealth of valuable information in this 300-page book written by Dr. Mazumder of the Delhi College of Engineering. Not only does it cover the wide range of topics that are involved in Irrigation Engineering, but there is the bonus of the author's experience of irrigation schemes in India.

This is a good text book. The different aspects of Irrigation Engineering are presented in terms of the fundamental principles and practical applications. Important formulae are not normally derived in detail, but the significance and application are discussed. There are numerous examples and representative calculations based on Indian field data. The breadth of coverage ranges from advice of the calculation of volumes of earthworks to prevention of silting and scouring. Each chapter is concluded by a series of "Review Questions"; these questions will encourage the reader to go back to the text to examine it more carefully.

But this is more than a text book since it raises many of the fundamental issues in Irrigation Engineering. For example the author acknowledges that the overall efficiency of an irrigation scheme is frequently between 20 and 30% rather than the higher values predicted in designs. Having recognized the practical limitations of irrigation schemes, the questions that need to be tackled for improved efficiencies are raised. The chapters on Flood Control, Waterlogging and Salt Problems and Management of Irrigation Water are especially valuable in identifying the practical problems.

The one danger of such wide coverage is that over-simplifications can occur. In his chapter on Groundwater the author writes that "Deep aquifers contain an inexhaustible quantum of water and that the yield can be assured in all seasons". Unfortunately there are many examples in India where the deep aquifers are over-exploited with the result that the yield has fallen significantly.

On the whole this is a worthwhile book to read both as a standard text and as a means of learning about Irrigation Engineering in India. At a cost of only £5.95 we can hardly afford not to purchase.

K.R. Rushton

Other books received:

Guide to the hydrology of carbonate rocks, final version prepared by Philip E. la Moreaux, Berry Morere Wilson and Beshir A. Memon from contributions by L.A. Heindl, D.J. Burdon, G. Castany, D. Langmuir, H. LeGrand and many others. S & RH 41, Unesco, Paris, 1984 345 pages. 120 ff.

Application of remote sensing to hydrology including groundwater by R.K. Farnsworth, E.C. Barrett and M.S. Dhanju. TDH, Unesco, Paris, 1984, 122 pages. Free.

Main Committee's Activities

The Committee's activities and meetings are now settling down into a long-term pattern, which is making their organisation much simpler. The timing of meetings, which are held in early January, April, July and November, has been planned to fit in with the annual pattern of business and the production of "Circulation".

The second Membership Directory (1984/85) was circulated several months ago and an addendum was issued later. Its production was organised by Mike Lowing, with assistance from colleagues at IH and in conjunction with the Institution of Civil Engineers. The computer listing held by the Institution is being improved so as to simplify the production of future issues and addenda. The latter are particularly important as the total membership of 354 in January 1985 has now risen to considerably over 400 (see page 8).

The preparation of an initial British Hydrological Directory, under the encouragement and editorship of Logan Jack is proceeding well and the first drafts of all sections by Main Committee members have been sent to him for compilation. We hope to publish it in early December, before the AGM. The final results of the analyses of the questionnaire on Professional Status and Qualifications and the Committee's proposals based on them will also be circulated at about that time. Discussions with other organisations have been held by Professor Paul Novak and Bob Sargent.

The organisation of the Society's National Meetings continues to take up a great deal of Mike Hall's time and also a large part of the Main Committee's meetings. In order to try to reduce this and to improve the advance planning of meetings, a small Meetings Sub-Committee, consisting of the President, the Hon. Secretary and two other members of the Main Committee, will be set up each year in October. They will prepare a proposed outline of the year's programme due to start in the following September. The Main Committee will finalise this in April and a printed programme will be circulated to Members in August annually. A preliminary notice of the outline of meetings in the following year will be included in each February newsletter, so that Members who feel that they can offer suitable presentations can approach the organisers. In this way it is hoped to involve a wide variety of the Society's members as speakers at meetings. If Members have suggestions for topics for meetings then the autumn is obviously the best time to send them to the Hon. Secretary.

We hope that, by the 1st August, there will have been a large number of entries to the Photographic Competition.

FORTHCOMING EVENTS

Meetings

FIRST INTERNATIONAL GEOMORPHOLOGY CONFERENCE, MANCHESTER — 15-20 September 1985

The third circular for this conference will be sent shortly to all those who have registered. Others interested in attending contact: Prof I. Douglas, School of Geography, University of Manchester, Manchester M13 9PL.

SECOND SOUTH AFRICAN NATIONAL HYDROLOGY SYMPOSIUM PIETERMARITZBERG — 16-18 September 1985

Key paper: "A systematic problem-oriented approach to hydrological data regionalisation" — Prof Ian Simmers (Vrije Universiteit, Amsterdam). Concurrent sessions on: Water Resources Management; Design Hydrology; Hydrometeorology; Mineralisation; Nutrient and Sediment Studies; Data Management Systems — Hydrological Model Studies; Effects on Land Use; Statistical and Stochastic Hydrology.

Contact: Prof R.E. Schulze, Dept. of Agricultural Engineering, University of Natal, P.O. Box 375, 3200 Pietermaritzburg.

INTERNATIONAL SEMINAR ON ENVIRONMENTAL IMPACT ASSESSMENT OF WATER RESOURCES PROJECTS ROORKEE — 12-14 December 1985

Themes: Water and eco-system dependency; Environmental (social, economic, ecological, health) impacts of water resources projects including reservoirs and groundwater development for various purposes; Environmental impact assessment procedures and practices; Institutional aspects of environmental impact assessment.

Contact: Dr U.C. Chaube, Water Resources Development Training Centre, University of Roorkee, Roorkee-247667 (U.P.) India.

DECISION SUPPORT SYSTEMS AND RELATED METHODS IN WATER RESOURCES PLANNING OSLO — 5-7 May 1986

Norway's contribution to Unesco's IHP-III. Main 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.

Contact: A. Carlsen, Ingeniør A.B. Berdal A/S, Kjørboceien 14, 1300 Sandvika, Norway.

VI INTERNATIONAL CONFERENCE ON FINITE ELEMENTS IN WATER RESOURCES LISBON — 1-5 June 1986

Numerical modelling of water resources; Exchange of ideas on new developments in Finite Elements; Comparison with other discrete element techniques; practical applications (model formulation, calibration and validation); Support software.

Contact: Laboratorio Nacional de Engenharia Civil, Avenida do Brasil, 101, 1799 Lisboa Codex, Portugal.

HYDROSOFT 86 International Conference on Hydraulic Engineering Software SOUTHAMPTON — 9-12 September 1986

This conference is concerned with development of software for hydraulic and water resource problems. First circular now out calling for papers.

Further details from: Wessex Institute of Technology, 52 Henstead Road, Southampton SO1 2DD.

IAHS at IUGG, VANCOUVER 1987 9-22 August 1987

First circular with details of proposed symposia and workshops available from IAHS Office, c/o Institute of Hydrology, Wallingford, OX10 8BB.

COURSES

FIFTH COURSE IN LAND RESTORATION

A four-day course on the principles of land restoration and their application is to be held by Land Capabilities Consultants Limited at Wolfson College, Cambridge, 23-27 September 1985.

The course will consist of two days of lectures and two days of field work and will cover subjects including drainage, soil properties, landfill, etc.

Further details from: Miss S.P. Corker, Land Capabilities Consultants Ltd., Times House, Willingham, Cambridge, CB4 5LH, tel: 0954 60888.

Diary

4 September
Welsh Hydrological Group.
AGM followed by "Hydrological hazards" — R. Walsh and A. Perry (University College, Swansea).
South Wales Institute of Engineers, Cardiff. 5.30 for 6.15 p.m.

16/18 September
North West Weather Radar Consortium and Institute of Hydrology.
(co-sponsors: WMO, BHS and Pennines Hydrological Group).
"Weather radar and flood forecasting" conference. University of Lancaster.

4 October
Scottish Hydrological Group.
"Scottish water law" — D. Mann (Forth River P.B).
Wellcome Room, Royal Society of Edinburgh, 22-24 George Street, Edinburgh. 6.00 for 6.30 p.m.

16 October
BHS Southern Section
Electronic and ultrasonic river flow gauging — 10 years on.
Afternoon site visit followed by evening meeting: Southern Water Authority, Hampshire.

16 October
Welsh Hydrological Group.
"Rainfall monitoring by satellite" — E.C. Barrett (Bristol University).
Department of Civil Engineers, University of Bristol. 5.30 for 6.15 p.m.

1 and 2 November
Pennines Hydrological Group.
Visit and tour of Frank Law Treatment Works at Garstang (the control centre for the Lancashire Conjunctive Use Scheme). Talk by R. Westleigh (Rivers Division, NWWA) on River Wyre Flood Control Scheme, and followed by tour of the works.
Numbers limited to 20: further details from A. Lewis (092 572 4321).

18 November
BHS Southern Section.
Digital mapping — scientific and operational applications — R.V. Moore (IH) "River networks and terrain modelling" — R.V. Moore (IH) and "Sewers and Water Mains" — N. Cullen (WRC).
Imperial College. 5.00 for 5.30 p.m.

4 December
Welsh Hydrological Group/Institution of Public Health Engineers.
"River Frome (Bristol) Flood Study" — T.G. Hughes and H. Richards (W.S. Atkins and Partners).
Department of Civil Engineering, University College, Cardiff. 5.30 for 6.15 p.m.

6 December
Scottish Hydrological Group.
"Engineering and operational aspects of the 84 drought" — I.W. Neil (Water Department, Strathclyde Regional Council) No. 2 Lecture Theatre, McCance Building, Strathclyde University. 6.00 for 6.30 p.m.

9 December
British Hydrological Society AGM.
Followed by national meeting, title and speakers to be announced.
Institution of Civil Engineers, London.

Copy Deadline for Issue No. 8 — 1st October 1985

Circulation is the quarterly newsletter of the British Hydrological Society. It is issued free to members but is also available on an annual subscription of £10.00. Please address all correspondence to the Editor, Celia Kirby, Institute of Hydrology, Wallingford, OX10 8BB. Tel: 0491 38800 ext. 264.