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DROUGHT ROUND-UP

Martin Lees (Institute of Hydrology) examines the progress of the drought and looks ahead a bit: could it get worse?

As part of IH's remit from the DoE to maintain the Surface Water Archive, we have been assembling a hydrological summary monthly since May. Sometimes, it seemed that most hydrometric and hydrological staff within the industry were moving offices; were on leave; are up to their eyebrows in Drought Orders or are waiting to find out who their next boss is. Notwithstanding all of that, the information came through on time. We now know that first class post from the south west is a next day service, but from Wales and the north west it is not. We know because these are the areas which have held our attention throughout the spring and summer.

In brief, we may say that the lack of rain in 1984 has been most severe in those areas which are susceptible to single season droughts. These areas have a combination of predominantly impervious catchments and a reliance on rivers and surface reservoirs for public water supply (PWS), with an expectation of regular frontal rainfall to sustain them.

In comparison, central, eastern and southern England need at least a two-season drought (winter-summer) to be seriously affected. These areas have had far fewer problems than the north and west, more reliant as they are on groundwater-maintained rivers and groundwater sources proper for PWS. January 1984 was the fifth wettest this century which, after an above average December, ensured a substantial level of groundwater recharge.

From April on, however, parts of the north and west have had an unprecedented low rainfall. In the north west and Wales the high and wet areas have been relatively the driest. For example, Thirlmere and Haweswater have experienced periods of between four and seven months which are the driest on record by a considerable margin. Pontsticill has similarly broken records for the four and five month periods. For the North West and Welsh water authorities as a whole, April-July and March-August rainfall return periods are in excess of 200 years; for the South West water authority, 50-150 years. Although below average, rainfall in the east and south for March to August have low return periods of five years or less.

It does look likely that Peter Walsh will be able to award the gold medal to the central Lake District as being the "droughtiest" of the summer!

In Scotland, December 1983 and January 1984 were the second wettest this century, but rainfall has been well below average since the end of March. April-July falls for Glasgow and the Solway Firth have been less than one third of average. Outside of these areas, the mainland has had about half of average. Low rainfall records have been broken; in Perth, from March to July, it has been the driest at least since 1829.

Rivers which are responsive to rainfall, typically those in the north and west, have reflected the rainfall pattern, showing long recessions, interrupted by the late May rain and occasional thundery activity. IH's summary subset of gauging stations (1 to 3 per authority) have experienced some record monthly minima. These are: the South Tyne and the Greta (NWA), 1 month each; the Wharfe (YWA), 2; the Fowey and Taw (SWWA), 2 and 1; the Yscir, Cynon and Conwy (Welsh), 1, 2, 2; and for NWWA the Lune and Leven, 1 each. Other stations and months have rankings second only to 1976. Figure 1 illustrates the hydrograph of the Taw, in north Devon, with the 1976 and average monthly hydrographs shown for comparison. The dry April depressed all our sample rivers below average, but since then the Stour (AWA) and the Upper Lee (TWA) have had monthly flows close to, or above average. Others in the south and east are generally still above 60% for August.

The rivers in Scotland have suffered, and many quite large ones have dried up completely. The south west has been the hardest hit. This has been compounded by the burgeoning use of spray irrigation, which is essentially uncontrolled. Many smaller streams are dry, with downstream abstractors losing their supply and effluents being discharged into dry channels.

Where recessions to the hydrographs have become established in the Chalk and Lincolnshire Limestone, their rates appear similar to 1975 and other dry summers, and levels are now below

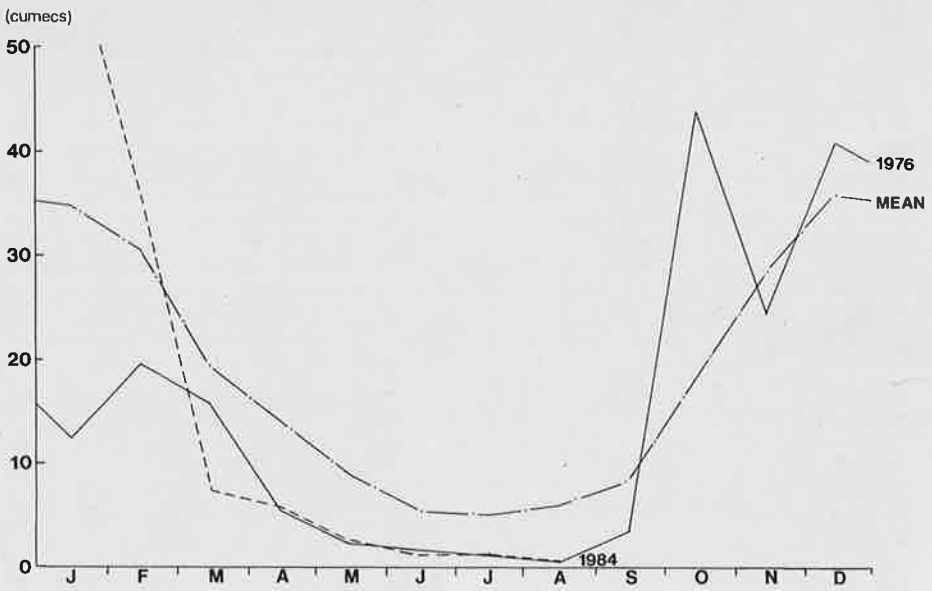


Fig. 1 Station 050001, the Taw at Umberleigh, gauged flows 1958-1980

average. Levels in the Permo-Triassic sandstones and the Magnesian Limestone are still above average.

All regions in England and Wales are showing soil moisture deficits higher than may be expected at this time of year. All areas north west of a line from Exmouth to the Humber were, during August, very much drier than average. Although the overall picture in 1976 was more severe, some areas in the west and north have deficits comparable to the 1976 values.

What next?

We are now entering a period when our interest turns to what we may expect during the winter months. We rely on winter rains to replenish surface reservoirs and augment groundwater resources. It is reasonable to ask what are the probabilities of having a dry winter. Analysing 214 years of rainfall data for England and Wales it appears that for a 6-month period, October start, 75% and 50% of average rainfall have associated periods of 12 to 14 and 450 years, respectively. In the west, of course, such return periods would be longer, and in the east, shorter. It does suggest, however, that a dry winter is not too remote a possibility.

A further analysis considers the recovery in SMD. Figure 2 illustrates two dissimilar areas, in south west Wales and Norfolk. Current SMDs from MORECS of 25th August are displayed along with average values. Average rainfall and an evaporation function have been used to define the recovery of SMD to field capacity. Recovery curves for average and 75% of average rainfall have been plotted. For the Welsh site, a drier winter than that shown is needed to delay recovery to 1985. Usually, deficits in Norfolk are not satisfied until November; from the current situation, 75% of average rainfall over the next five months would delay recovery until mid January. This illustrates the importance of winter rains to the drier east and south; greater than average infiltration is now necessary to raise groundwater levels to average, as higher SMDs will delay recovery of soil moisture to field capacity.

So, even without alarmist press reports, at least average winter rainfall is desirable to allay concern over next summer's water supply.

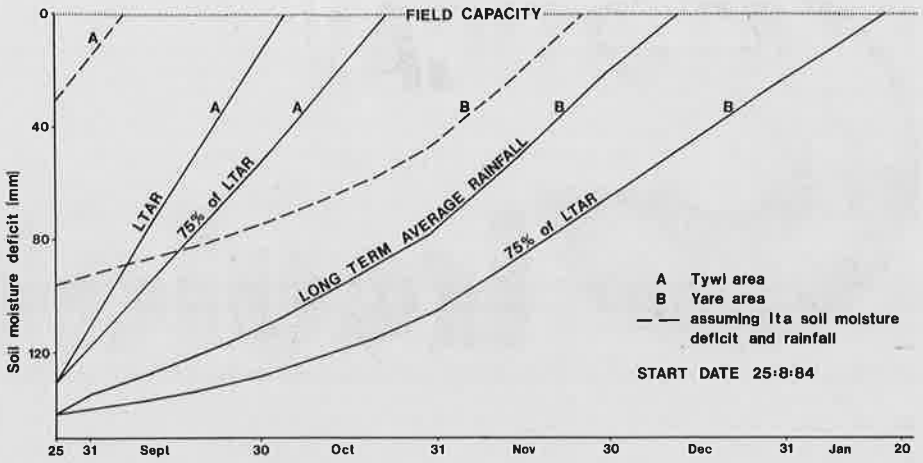


Fig. 2 Recovery time diagram of SMD

Forth RPB tries the RAFT river gauging technique

The RAFT system uses an air pipe laid across the river channel to create a curtain of rising air bubbles. The downstream displacement of the initially straight line of bubbles is directly proportional to the mean velocity of the current through which the bubbles rise so a measurement of this displacement can give a direct discharge measurement. In practice the pattern of bubbles on the water surface is photographed and after digitising the negative or print a computer is used to calculate the discharge.

The Forth RPB were the first to take delivery of the equipment, including the necessary software, which was installed in 1982 and an evaluation of the system has been made over two complete summers. We were interested in testing the system in two situations where our normal method of current metering would not work; where frequent cutting of aquatic weeds is necessary and where water velocity at low flow falls below the stall speed of a current meter. The system was therefore installed at two gauging stations where these problems are encountered.

Correct installation of the system requires that the air pipe is laid straight and normal to the flow. At our weedy site we laid concrete kerbstones across the river bed and up the banks. These were of the Safticurb type which are hollow and allowed us to install the pipe within the kerbing thus keeping the pipe straight and protecting it from vandalism. This method appears to work successfully and the air bubbles do not seem to be retarded or deflected by the kerbing.

Installation at the low velocity site was more difficult because of the depth of water and the soft nature of the bed. Here we used a boat to lower the pipe which was weighted by attaching engineering bricks along its length. Correct installation of the pipe, and its subsequent movement, is particularly important at a low velocity site where displacement of the bubbles on the surface will be small. The difficulties in achieving and checking this are considerable.

So what of the results? At the weed infested site the bubbles appeared to be unaffected by the weed but the gauging results, compared to simultaneous current meter gaugings, suffered from considerable variability. Variation from the current meter gauging ranged from +14% to −32%, but was generally negative so perhaps some retardation was occurring. The real problems arose when the weed broke the water surface and the bubble pattern could not be discerned on the photographs despite the efforts of a professional photographer and a variety of filters. To be fair this site is badly infested by a potamogeton type weed which has thick stems and large leaves. The system might work more successfully where more normal aquatic weeds occur.

The low velocity site suffered from different problems. At low velocities the displacement of the bubbles was very small and instead of floating off downstream tended to hang around their point of emergence and obscure the emerging bubble pattern. Sometimes the bubbles would be blown upstream by the wind and no result could be obtained. Because the actual area delineated by the bubble's displacement was very small the error of the system became very high; very different results were obtained from the same photographs by different operators. Where possible a current meter gauging was taken at the same time as the RAFT gauging and the RAFT gaugings varied from −41% to +0.8% of the current meter result, once again exhibiting the tendency to register less than the standard technique. At the lower end of the rating current meter gauging was not possible but comparing the RAFT results against an extrapolation of the rating shows this tendency much increased. Clearly the extrapolation of the rating may be incorrect but using the RAFT gaugings gives flows as low as 0.12 l/s/km^2, some ten times lower than those recorded on similar catchments in Scotland.

We cannot claim to have exhaustively tested the RAFT system but it does appear to have a number of drawbacks. It appears to be unreliable at sites where it is most needed, i.e. where current metering is not possible, and is dependent on good weather conditions for adequate bubble definition and photography. The error of the gauging depends heavily upon the area of bubble displacement and therefore upon volume of flow and channel cross section. However, there are doubtless other applications where the technique would work successfully: if anybody would like to try them we know of a complete system going cheap!

H. Coltart
R. J. Sargeant

STATISTICAL FLOOD ESTIMATION

BHS meeting at Newcastle 15th June 1984

Since its publication in 1975, the Flood Studies Report has become the basis for most flood frequency studies in this country, and the statistical method of estimating peak flows of given return period at ungauged sites is probably the most frequently used technique. In part, because of the widespread familiarity with the method, it has attracted much comment and criticism especially on the regionalisation of flood frequency and variations which exist at boundaries. Some of these old problems resurfaced at the BHS meeting in Newcastle but in addition new techniques of regionalisation and of choosing and fitting regional flood distributions were described which, if accepted nationally, would have a profound effect on the outcome of estimation at individual sites.

The morning session was taken up with two talks sketching in the background to regional flood frequency estimation. Our host **Professor Enda O'Connell** considered the principles of choosing and fitting flood frequency distributions as a framework for the introduction of some new and versatile techniques to incorporate in the hydrologist's tool kit.

He described the Wakeby distribution, an 'all-singing-all-dancing' five parameter distribution which can not only give a good fit to data generated by other distributions but also reproduce characteristics of real-world data (specifically the relation between skewness and kurtosis and the occurrence of outliers) that other distributions fail to do. However because of the multiplicity of parameters it is appropriate for fitting regional data sets rather than individual stations. He illustrated the technique of probability weighted moments (PWMs) as the only suitable way of fitting the Wakeby distribution. PWMs can also be used to fit the generalised extreme valve distribution (GEV) and are better in fitting small samples than maximum likelihood.

Professor O'Connell also introduced the concept of 'robustness', a property of the estimating procedure which gives good estimates of the T year flood across a range of possible parent distributions. This property can be investigated by Monte Carlo simulation — a procedure more fully illustrated in the afternoon by Professor Eric Wood.

Max Beran's morning contribution was concerned with the practical problems of devising a method of flood estimation to be used on a national basis, the philosophy of the Flood Studies method and the steps in its execution and where, in the light of recent research and development, improvements might be made. The Flood Studies philosophy was expressed in his epigram: 'Explain what you can; average what you can't'. Explanation was concentrated on the index flood. However the spread and asymmetry were not found amenable to explanation in the same way and were therefore averaged to give regional and national flood growth curves.

A description followed of the graphical method used to average the data and how the resulting regional flood frequency curves contrasted with those derived analytically using the same data — based on the work of Jim Wallis and Eric Wood visiting at IH during 1983/84. All analytical fitting methods (PWMs and maximum likelihood) gave regional flood frequency curves much flatter than those derived graphically. One example showed reductions in estimated discharge of 15% and 30% at 50 and 500 years respectively.

The immediate question arising from the discovery of this discrepancy is, which is right? And, what if anything is wrong with the plotting position of points on the graphical method as the analytically derived lines do not fit the points.

A further difficulty was uncovered in the way in which historical flood data had been incorporated in the Flood Studies growth curves. Serious reservations were expressed later when the extent to which these further steepened the FSR growth curves was demonstrated by Eric Wood.

During the afternoon **Eric Wood** took us more deeply into the comparative accuracy of the FSR and analytical techniques by a series of Monte Carlo simulation experiments. Starting with an assumed underlying flood frequency distribution with known parameters, a set of samples were generated and fitted with (a) FSR graphical method (b) GEV using PWMs and (c) Wakeby using PWMs and the estimated quantiles compared with the quantiles of the parent distribution. This was done both for a homogeneous region in which individual stations all had the same statistical properties and a heterogeneous region in which there were variations from site to site.

These tests demonstrated that the FSR technique (or at least a computerised version) gives results which are more biased and which have considerably wider confidence limits than by the other two methods; the bias is generally but not always positive. He suggested that for heterogeneous regions typical of the real world, the FSR technique gives undue weight to stations with short records with outliers — sites where the information is least reliable. He suggested that it may now be time to rework the UK floods data using the more robust GEV or Wakeby using PWMs.

The talk by **Neil Whiter** (SWW) illustrated some of the potential difficulties of accepting a new technique in which the magnitude of the T year flood is reduced. It was felt that in SW England the FSR regional growth curve underestimated discharges and the flood data were therefore reworked by the FSR method but including recent data. The new growth curve is considerably steeper.

For the designer of flood protection works, or the householder whose lounge suite and video have recently been submerged, the argument that the statistical techniques is robust and not unduly influenced by isolated occurrences of this sort, is unlikely to hold much water. And the problem is by no means entirely psychological. Until we can differentiate the physical controls on flood frequency from the random component, it can always be claimed that the occasional occurrence of a very large event is a feature of the catchment.

This leads directly to the second main area of discussion. How are the physical controls on flood frequency to be defined? As Max Beran had suggested, flood frequency is controlled not by region or location but by morphological and climatic characteristics which may (or may not) be shared by catchments within a geographical area.

Mike Acreman (Forth RPB) and **Gordon Sinclair** (St Andrew's University) addressed this problem in a new and interesting way using Scottish data. A technique was used to identify catchment clusters with shared characteristics. Several alternative sets of clusters were derived and then each applied to the sets of flood frequency curves to see which could best explain the differences by looking at the ratio of between-cluster to within-cluster variation. The results from the most appropriate set are intuitively plausible; for example all catchments with large lochs are grouped together as are steep upland basins. There are several important implications of this method.

> The clusters are not necessarily discrete geographical areas. Catchments can be assigned a probability of membership of a cluster — a fractional membership of more than one cluster — thus going some way to overcome the problem of discontinuity at regional boundaries.

Jim Wallis in the final contribution raised questions, to which he acknowledged Mike Acreman had already provided part of the solution, on the identification of catchment characteristics influencing flood distribution.

> How to classify into sub groups which have explanatory value outside the region of derivation.
>
> How to identify hidden variables and spurious correlations.
>
> How to determine the number of sub groups supportable by the data.
>
> How to test the classification in a statistically independent manner.

His outline of a possible approach showed much in common with the Scottish study, stressing the need to make the catchment classification independent of the flood data. He suggested principal component analysis as a basis for identifying sub-groups, followed by the determination of sub group growth curves, then an iterative process of combining and splitting groups to arrive finally at a simple and hydrologically sensible classification without inexplicable jumps at boundaries.

It is my own feeling that this meeting at Newcastle will come to be regarded as a milestone in flood estimation in Britain, in that the various statistical, physical and

spatial strands are for the first time beginning to be woven into a coherent pattern. The British Hydrological Society can claim not a little of the credit for this in providing the loom on which the cloth is being woven. The geographical contribution in their sphere of expertise on spatial analysis was particularly welcome in a subject traditionally worked by engineers and mathematicians. But where were all the other academic geographers?

There are still many loose ends. What, for example, are the implications for the FSR rainfall growth curves which were similarly derived? Are there knock-on effects on the rainfall runoff method? The effects of inter-correlation of large events on the derived return period is still an unresolved area.

In conclusion may I crave the indulgence of speakers and contributors to discussion for any adjustment or omission of points to secure better fit to my intuitively derived line.

D. R. Archer

In view of the interest which this topic has aroused, we invited those responsible for the maintenance and improvement of the Flood Studies Report to describe their reaction to the implied criticism of the FSR regional growth curves. Have they really led to over-design?

John Sutcliffe (IH) gives a considered response.

Before answering the question, it might be useful to mention some recent publications.

Flood Studies Supplementary Reports are available to all FSR buyers. No. 15 in the series was a newsletter and it described the planned response to a list of research requirements produced, by **Phil Johnson**, following the 1980 Manchester Conference "Flood Studies Report — Five years on". Tasks 1 and 2 on that list covered some of the issues which have been raised again recently as a result of the several presentations by Messrs. Wallis and Wood. Although there is no denying that these recent criticisms are more penetrating and call for an accelerated and extended research programme to achieve their satisfactory resolution, it is possible to allay some of the more extreme fears right away.

Turning to the Editor's question — have the growth curves caused systematic overdesign? — it is true that our American colleagues were at first led to believe that this was so. However, it has not yet been made sufficiently clear that, in their simulation tests, they were using a computerised version of the FSR procedure which was significantly different from the graphical method adopted in the Report. For example, different standardising procedures are employed and no use is made of station groups within each region. The effect was to steepen derived growth curves, e.g. for the national data set (excluding historical data), the 100 year growth factor from the graphical procedure is 2.45 compared to 2.73 from the computerised version used by Wallis and Wood.

We have produced a computerised version designed specifically to match the original graphical procedure. Applying the same robustness tests to simulated data as used by Wallis and Wood, it was found that there was in fact a small *downward* bias in the procedure and a variability less than half that attributed by them to the FSR method.

While results from simulation experiments cannot be directly applied to curves based on real data, it is clear that the claimed upward bias in the published FSR procedure does not exist. The figure shows growth curves for Northern Scotland produced by three algorithms: the earlier computerised version of the FSR method used by Wallis and Wood (WWFSR), the more faithful algorithm (MFFSR), and the PWM estimation scheme (PWM). It is seen that the PWM and MFFSR curves are almost identical, contradicting the claim made in the above account of the Newcastle meeting (sixth para.) that analytical fitting schemes always give much flatter growth curves. Simulations show that the FSR method of fitting is not as *robust* as the Probability Weighted Moments scheme (advocated by Wallis and Wood) — the variability is still 30% higher — but at least users can be assured that the FSR procedure is not unduly biased.

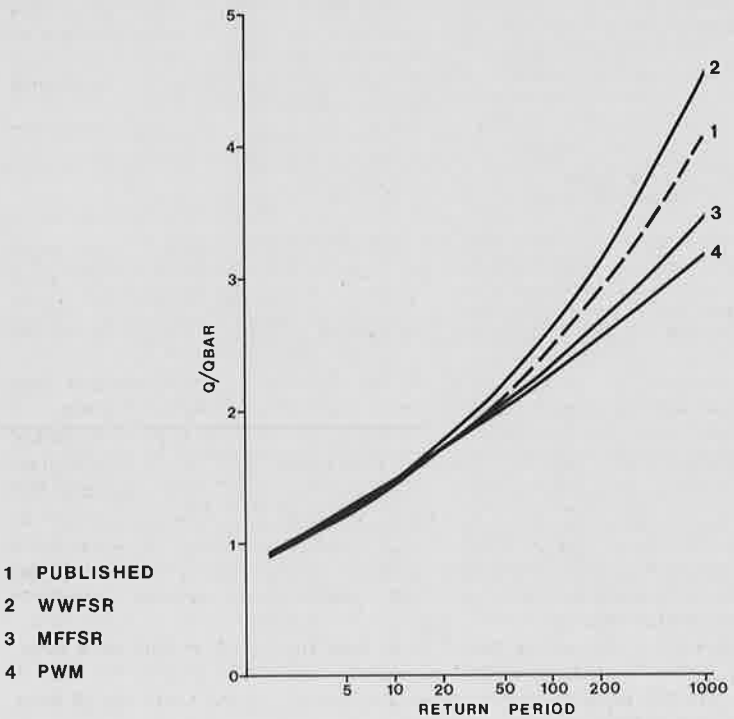
The higher variability associated with the FSR procedure is a result of the greater weight given to the higher floods. If — as with PWM — the fitting procedure pays little regard to the presence or absence of outliers in the sample, it follows that the variability (a measure of the range of fits from different samples) will be less. The inclusion of *historical data* therefore exacerbates the difference. Very large floods with much uncertainty attached to their magnitude and to their return period will clearly have more of a dominating effect in the FSR procedure. Whether the effect will always be to steepen the curves is debateable. The inclusion of historical data led to steepening of the East Anglian and Scottish curves; elsewhere, the curves were flattened or largely unaffected.

The Institute's plans to extend the database have been speeded up. Annual maxima lists have been brought up to date and the extraction of all peaks over a threshold (i.e. to give an average of 3–5 per annum) will continue using chart microfilm or computer records where available. On the analysis front, **Steve Wiltshire** is studying methods of grouping catchments similar to those being used by Mike Acreman. Indeed, the latter's recent recruitment to IH has further strengthened our expertise in this area.

Other investigations relate to the wider issues of regional flood distribution and methods of parameter estimation, standardisation procedures and the inclusion of historical flood information.

In conclusion, we feel that the Newcastle meeting was, as **Dave Archer** claims in his review, a most important event. It has helped to focus attention on the important topics for the next two or three years. While users can be reassured that the existing FSR growth curves are definitely not as dubious as claimed by some critics, we can look forward to revised procedures leading to improved methods of flood estimation. Our optimism in this regard owes much to the industry of our American visitors and we would like to record our thanks to them.

[Footnote: Interested readers might like to watch out for the March 1985 issue of the Journal of IAHS which is planned to include several papers on this subject. Ed.]



Publications

Peter Walsh has sent us a copy of his report of his Winston Churchill Memorial Trust visit to the States to study hydrometeorological data collection practices and asks that we let readers know that further copies can be obtained direct from him at North West Water Authority, Dawson House, Great Sankey, Warrington WA4 3LW.

The Middlesex Polytechnic Centre for Urban Stormwater Pollution Research has recently issued Reports 7 and 8 in its research publication series. These reports cover heavy metal speciation and highway runoff quality; details available on request to Bryan Ellis at the Centre, Bounds Green Road, London NE11 2HQ.

The latest additions to the IH report series are "Water quality modelling, forecasting and control" by Paul Whitehead (Report No. 88) and "A Review of British flood forecasting practice" by Duncan Reed (Report No. 90). Copies of these are obtainable from the Library, Institute of Hydrology, Wallingford OX10 8BB

REAL WORLD FLOODS

BHS Southern Section meeting 2nd July 1984

Forty-four members and guests, including a Russian visitor to IH, gathered at Imperial College on the 2nd July to hear three presentations on the theme 'Practical River Flood Studies'. John Sutcliffe of IH, refreshed by his annual field visit to the Thames (at Henley) the week before, chaired the meeting.

Although the presentations had a common theme, the differences were more obvious than the similarities, which were that all the studies were by consultants, of floods in rivers, and used computers.

River Ancholme, Lincolnshire

Graham Thompson of Binnie & Partners described design studies for the River Ancholme in Lincolnshire. The river is canalised into a wide, straight channel with a very shallow slope. It flows into the Humber through a tidal sluice. When closed by the tide, the sluice affects river levels for a substantial distance upstream. Thus flood levels are caused by a combination of river and tidal events.

A mathematical model developed in-house was used to simulate flood events, apparently to an accuracy of ± 5 cms in predicted levels. Hydrographs of river inflows of various return periods were generated from a mixture of Flood Studies Report equations and recorded data. Tidal data was analysed to get a frequency distribution of the length of time the sluices closed during each tide.

The main interest lay in the method of combining the probabilities of river inflows and tidal events to give probabilities of levels in the river. The wrong method is to say that the levels caused jointly by, say, a 5 year flood and, say a 5 year tide, are 5 (or 25) year levels.

Mr Thompson described how lots of combinations of events were simulated to predict river levels. The probability of each combination is known. By finding and summing all events giving the same predicted level, the probability of that level occurring can be found. A semi-graphical procedure was described which saved the effort of simulating all combinations.

In discussion, it was pointed out that the method only worked when tides and river floods were independant. However this was not thought to be a difficulty for the Ancholme study. The 'controlling' events had low return period; floods up to 5 or 10 years, tides occurring several times a year. These events were independent.

Aguan River, Honduras

V. R. Baghirathan of Sir William Halcrow & Partners transported us across the Atlantic, in scale of basin and study, and in levels of development of the river basin.

The Aguan basin covers 11,000 km^2, rises in places to 2,500 m, and has a tropical climate with average rainfall varying across the basin from 900 to 2,500 mm. It is occasionally hit by hurricanes; ; Fifi in 1974 deposited 200 mm in four days. Agriculture is not yet developed, drainage is not organised. Very different from the Ancholme!

The project was to prepare a Hydraulic Master Plan for agricultural development of the basin under UN sponsorship. In fact four master plans were prepared, each with different political, social and economic objectives. The hydrology of such a large project was too much to describe fully in the thirty minutes available, and could only be outlined.

Four models were used in the hydrological studies, three computer based and one physical. They were:

- a rainfall-runoff model to generate synthetic flood hydrographs from each sub catchment. Seven parameters represented each sub catchment.
- an unsteady flow model for routing floods through the river network.
- a sand transport model.
- a physical model of a road embankment which restricted the river's capacity.

A question from the floor about sediment accretion revealed some of the practical and political problems of working in developing countries. Sediment problems are getting worse because landless peasants are moving into the forests and cutting down trees to make space for farming. Control is virtually impossible: the pressures are too great, the political will is too weak, and no alternatives are available. Introducing conservation methods needs resources which aren't available, and political will. From the hydrologist's point of view, finding out what is happening is virtually impossible.

Sherborne, Dorset and Ashford, Kent

Marie Lindley and **Julian Smith** of Rofe Kennard and Lapworth brought us back to small scale problems in pleasant England. Both their studies were in urban settings.

The River Yeo runs through the edge of Sherborne. As with so many English towns, development has restricted the channel capacity and now does not leave enough space to improve the channel to carry the design flood. In a short stretch of river there are four low bridges, four right angle bends, walling of the banks, and a variety of services over, under and along the river.

FLUCOMP 2, an early release of the HRS steady flow model, was used to investigate alternative solutions. A mix of downstream improvements and a short flood relief channel was adopted and has now been constructed.

At Ashford, the study was of a potential urban area. The town is a growth centre and the best land for development is in the flood plain. What would be the effects of the new urban development on floods and could they be reduced enough to allow the development to proceed?

The river system is complicated by four tributaries and channel constrictions in the town but was successfully modelled with the unsteady flow version of FLUCOMP. Trials showed that the development could go ahead if a reasonable floodway was left and improvements were made to the downstream channel through the urban area.

It was also necessary to avoid detrimental effects to the rest of the river system. FLOUT, the HRS variable parameter Muskingham-Cunge flood routing model was used with FLUCOMP to show that off channel storage would achieve this. Gravel is being taken from a suitable site for flood storage, and so a ready made hole will be available when needed. The interesting situation has arisen of requesting the gravel extractor *not* to restore the site to its original condition!

Close

The lively meeting closed at 8.00 p.m. A vote at the beginning had shown a small majority against such a late end. In future, evening meetings will run from 5.00–7.00 p.m., allowing everyone to get home before their dinners are ruined from being in the oven too long.

David Lerner

From the Editor:

Right from the beginning, it was agreed that we should try and produce four issues of the newsletter every year. At the last Committee meeting we moved one stage further in tidying up our affairs by agreeing that we should aim for delivery dates to members of as close as possible to the first day of February, May, August and November.

This will of course make matters easier for the ICE distribution system if they can plan in advance and coordinate mailings to members of all Society business.

However, in this first year, we can't quite get it right: to merge what should have been the August issue (No. 3) with the November one (No. 4) would have been one solution but we have decided against this. We are therefore getting this issue out as soon as possible after the previously published 31.8.84 copy deadline and then going straight on to No. 4 for the 1st November. There are some items which ought to appear in *Circulation* before the AGM (now fixed for 10 December) and which cannot be ready before the end of the Society's financial year, plus some matter left over from this edition.

It therefore seemed pointless to give a copy date for No. 4 in this issue since, even as you read this, I shall probably be proof-reading the galleys for No. 4. However, if there are any burning issues, please give me a ring and I will try, at least, to fit in a "Letter to the Editor".

WOW IH

Thus read the welcome, inscribed in the earth of a Colorado hillside, which awaited the IH Unit of Fluvial Geomorphology as it began fieldwork in a Rocky Mountain river. (Only disparaging calumniators would cavil at this interpretation and point out that "WOW IH", read upside down, forms a more traditional American greeting!)

With travel and subsistence covered by a NATO scientific grant, three of the Unit's staff (**James Bathurst, Graham Leeks** and **Malcolm Newson**) visited the Rocky Mountain National Park in June to work on the Roaring River in a cooperative project with Colorado State University, studying the relationship between the supply of sediment to a river channel and the storage and unsteady movement of sediment within the channel.

To this end, measurements were made of sediment input, output and storage in a gorge cut in the river valley by the flood wave from the Lawn Lake dam failure of July 1982. The study complements research into sediment systems carried out by the Unit and contributes to the overall study by Colorado State University of the response of the downstream river system to the flood.

Using specially designed equipment, the team sampled the sediment discharge with enthusiasm, often overnight (a chilly occupation at an altitude of 9,000 feet). Stereoscopic photography and surveying enabled cliff erosion to be monitored and other activities included gauging the water discharge and measuring the size of the bed sediment with a pebbleometer. Meanwhile, back at the cabin in the forest, amongst chipmunks and porcupines, the sediment samples were dried in frying pans on the stove, giving new meaning to that popular southern USA food, grits.



Graham photographs sediment on a shoal at the lower end of the gorge.

Weather was cool during the visit so snowmelt occurred at a moderate rate and river flows did not cause much cliff erosion. This prompted a discussion of means of increasing the sediment transport by inducing an artificial cliff collapse, an option described as pure dynamite by the natives who expressed their consternation by changing the Unit's name to the Fluvial Terrorist Unit. Nevertheless, an extensive and exciting set of data was assembled showing, amongst other findings, the importance of in-channel storage in regulating the output of sediment from the gorge with respect to the unsteady input.

The research aroused considerable interest among the local media which included television channels from Denver and Radio KSIR, the local station at Estes Park, "as much a part of your summer fieldtrip as crossing the Continental Divide" (which the Unit just failed to do).

J.C.B.



Graham measures sediment discharge with a Helley-Smith bedload sampler.

Main Committee's Activities

A Meeting was held in early July and, for the first time, was attended by representatives of the Society's Midlands and Southern Sections, **Dr Richard Wood** and **Dr Howard Wheater** respectively. The main topic was the programme of meetings for 1984/1985 and details of these appear in the Diary. There has been a good response to the request for proposals for topics and venues but further suggestions will be very welcome. Similarly, if members wish to propose activities which they feel the Society should arrange, then please put these forward.

Royal Commission on Environmental Pollution

The Society was invited in May to submit evidence on the issue, pollution and waste, now being considered by the Royal Commission. The letter was circulated to all members and the three replies received have been forwarded to the Commission.

The response was less than anticipated, but this may have been due largely to many members contributing through the organisations for whom they work. More than two hundred invitations had been distributed by the Commission to, amongst many others, Water Authorities, Purification Boards, Universities, Research Establishments and Local Authorities.

This approach was welcomed and, in replying, the Society's enthusiasm to take part in future, similar activities was expressed. We hope that more invitations of this kind will be received, as we feel sure that the Society has a useful role to play in contributing to such broader issues.

PROFESSIONAL STATUS AND QUALIFICATIONS

Members will be interested in the first results of analyses of the replies to the questionnaire circulated in July. By mid-August 123 replies, nearly 30% of the membership of 425, had been received. Some findings are:-

- 74% (91) regard themselves as hydrologists, with a further 11% being hydrologists previously.
- 34% (42) feel that they have been affected adversely by the present situation; with reduced job opportunities being the most serious aspect.
- 54% (67) are dissatisfied with the present situation, 36% are satisfied and 10% do not have clear views. Interestingly, more of the 53 members of the Institution of Civil Engineers are dissatisfied (60%) than are satisfied.

Many members described their views, suggestions and experiences and these will be very helpful. When analysed fully the results will be considered by the Main Committee and further steps planned. Meanwhile, many thanks to all those who completed the questionnaire.

THESES

Gaddi G.K. Ngirane (Imperial College) was awarded a PhD from the University of London for this thesis 'Influences of Storm Dynamics on Flood Hydrographs'.

Synopsis A distributed non-linear rainfall-runoff model has been calibrated using a range of catchments to investigate model parameter sensitivity to catchment conditions. Synthetic catchments with a range of area and characteristics were prepared and modelled using realistic model parameters and, on the basis of available observations of storm velocities, synthetic storms were moved over the catchments and the resulting hydrograph characteristics analysed.

The results show the importance of storm speed and direction on the hydrograph characteristics such as the peak discharge. On the basis of these results, recommendations are made for improved drainage design practice.

Costas Koullis (Imperial College) has successfully defended his PhD thesis 'Exponential Functions in the Finite Element Simulation of Groundwater Quality Problems'.

Synopsis Three elements using exponential functions have been formulated to deal with the oscillations in the numerical simulation of convective mass transport. The exponential functions have variable curvature reflecting the flow conditions and can be applied to the whole range of mass transport; in pure diffusion they reduce to linear functions. The exponential functions have the same stability as the method of upstream weighting, becoming less sensitive to changes in velocity as the velocity increases.

Andrew Williams gained his PhD from Plymouth Polytechnic for his thesis on 'Solute Pathways in the Narrator Catchment, Dartmoor'.

Synopsis Solute concentration of water samples collected at various points along the hydrological pathway from the atmosphere to the stream were investigated. The experiment was conducted in a small (4.75 km^2) drainage basin on Dartmoor and the experimental design was based on three hillslope transects through different vegetation types, namely acid grassland, add grassland invaded by bracken and sitka spruce forest. Water samples of precipitation, throughfall, litterflow, interflow, springs and the stream were collected regularly. Spatial differences at points within each transect were due to their discharge and position on the slope; those between transects were the result of vegetation differences. Temporal variations in solute concentration were examined and related to sources of the chemicals, hydrometeorological conditions, season and catchment characteristics. A geochemical balance was calculated from the atmospheric inputs and losses in the stream; the mineral sources and their alteration products were investigated. The chemical denudation rate for the catchment was computed and weathering was found to be still active and highly localised. The implications of this result for granite landforms is discussed.

Robert Parkinson (Seale-Hayne College, Newton Abbot), was awarded a Ph.D.for research conducted at Birkbeck College, University of London, for a thesis: 'Soil-water dynamics of underdrained clay soils'.

Synopsis Distinct seasonal phases of water disposal from an underdrained London clay soil were identified by analysing drainflow response from six tile laterals and two tile networks over up to four drainage seasons. Drainflow was related to the soil water regime, which was measured regularly over the experimental period. The different hydrological responses of the tile drains were also related to topographical control of antecedent water contents. In addition to relative slope position, absolute slope was found to control drain efficiency, those drains on the steepest slopes having the lowest total storm discharge per unit drain length during the winter period. A laboratory study using a two dimensional variable slope drainflow model showed that total storm drainflow varies inversely with slope angle, confirming the field evidence.

NEWS FROM MEMBERS

This column has shrunk again — compared to the previous issue — but we're blaming the drought! It's made many of you too busy to write and has also resulted in all the relevant news being siphoned off to a separate feature.

MEMBERS ON THE MOVE

Logan Jack writes with news of the most recent Water Authority reorganisation.

"On September 1st the Welsh Water Authority was restructured into three Divisions plus Headquarters. The three new Divisions have their centres in Nelson, Haverfordwest and Bangor with main outposted offices in Hereford, Cardiff, Swansea and Mold.

Two members are leaving WWA — **Jerry Sherriff** moves to Kent and **Paul Crockett** is returning to university to do a PhD. Members moving within WWA are **Nigel Hendley**, Reservoirs Engineer in Cardiff; **Allan Lambert**, Water Manager in Bangor and **Alan Tillotson**, Senior Engineer in Brecon.

The remainder stay in their present locations, mostly with alterations in their job titles and responsibilities. These members are (listed with their new job titles and locations): **Jean Frost**, Hydrologist in Haverfordwest; **Steve Gallimore**, Area Hydrologist in Hereford; **Logan Jack**, Technical Officer (Reservoirs and Hydrology) in Brecon; **John Mosedale**, Area Hydrologist in Cardiff and **John Riden**, Hydrologist in Mold."

The Thames re-organisation is reaching down through the management hierarchy. The fate of most BHS members is reported to be still in the balance. **Jane Richardson** resolved part of hers, however, by marrying to become Jane Kinneburgh.

David Sargent is presumably approaching the end of his two year leave of absence (which started in February 1983 but we've only just heard!) with the Snowy Mountains Engineering Corporation in Australia.

Kath Lacey, who is currently writing up her PhD on nutrient input to Loe Pool, Cornwall, will be joining Kingston Polytechnic's School of Geography in September as a temporary lecturer.

David Lerner left Binnie & Partners at the end of September to become a lecturer at Birmingham University. He will be in the Department of Geological Sciences specialising in groundwater pollution.

Elizabeth Shaw is taking early retirement from the Department of Civil Engineering at Imperial College after a long association with the postgraduate course in engineering hydrology. She intends to remain in London for a few years dividing her time between rainfall analysis on a newly acquired BBC microcomputer and cultural activities in London neglected over the years. A farewell dinner is being held at Imperial College on Tuesday 9th October. Old students wishing to attend should contact Miss J. Barritt on 01-589 5111 ext. 4719/4720.

FROM DOWN UNDER

Frank Law, our South Pacific correspondent, writes with news of an interesting gathering at the Commonwealth Science Council workshop in Suva (Fiji) last July. The topic was Water Resource of Small Island Nations with particular reference to the Pacific and Indian Oceans. Two British hydrogeologists from Wallingford were there, Frank spoke about surface water resource analyses for small islands (based on a recent project in the Cook Islands), and there was other British involvement alongside Commonwealth, French, and USA contributions. The proceedings are thought to be well worth obtaining.

Mike Lowing (IH) will be sorry to have missed that meeting as he is involved with an ODA-funded project to monitor short duration rainfalls at a series of sites on the transect of Guadalcanal (Solomon Islands). He is due to visit in October and promises a report for a future *Circulation*.

INSTRUMENTATION

[*Other than the separate article describing experience with the rising float technique for flow measurement, the only contribution this time comes from Thames. They are, we know, interested in furthering exchanges of information between Authorities and, in this particular field, there may be merit in BHS organising some more formal liaison. Much depends on the future role of IMOG but any thoughts on the matter would be welcome. — Ed.*]

Thames WA have had about two years experience with 30 Ferranti optical shaft encoders at their telemetering water level recording sites (Contact: **Tim Webb**). The Datastor logger they told us about in the last *Circulation* has successfully downloaded data to their HP 45B (**Brian Greenfild, Jane Allam**). Finally, they are buying three multi-channel current meter timer/counters from Computrol. These can handle the information from a number of current meters simultaneously (**Tim Webb**).

Forthcoming Events

Seminar

A one-day seminar on the strategic implications of United Kingdom catchment research, is to be held in Leeds on 9th January 1985 during the Institute of British Geographers annual conference.

Themes covered:

Water yield; nutrient loss and enrichment; microbiological aspects; impoundment sedimentation; land use effects on upland acidification.

Speakers:

Dr Tim Burt (Huddersfield Polytechnic)
Dr Gareth Roberts (Institute of Hydrology)
Dr John Stoner (Welsh Water Authority)
Dr Peter Walsh (North West Water Authority)

Convenors:

Dr David Kay (Saint David's University College, Lampeter, Dyfed. 0570 422351).
Dr Adrian McDonald (Leeds University, 0532 31751).

DIARY

3 October
Welsh Hydrological Group.
"Practical uses of weather radar" — Introduced by R. C. Goodhew.
Welsh Water Authority, Brecon.

5 October
Scottish Hydrological Group.
"Recent developments in Meteorological Office services for Hydrologists" — Introduced by J.G. Allardice, G.P. Butler and speaker from Met. Office, Bracknell.
McCance No. 2 Lecture Theatre, University of Strathclyde, Glasgow.

15 October
BHS Southern Section.
"Chalk Hydrology" — Introduced by D. Cooper, S. Foster, D. Oakes and B. Greenfield.
Institute of Hydrology, Wallingford.

23 October
Institution of Water Engineers and Scientists, Midland Section.
"Forecasting droughts and floods" — Introduced by R. A. Bailey, J. R. Douglas and R. C. Goodhew, Newbold Hall, Royal Spa Centre, Leamington.
(BHS members are invited to attend.)

29 October
BHS National Meeting joint with Royal Meteorological Society.
"Climatic change and water resources".
Institution of Civil Engineers, London.

7 November
Pennines Hydrological Group.
"Estimation of river flows at ungauged catchments" — Introduced by J. Piet.
Yorkshire Water Authority, West Riding House, Leeds.

19 November
BHS Southern Section.
"Environmental problems and water quality management" — Introduced by R. Skeffington and M. B. Beck.
Imperial College, Department of Civil Engineering.

20 November
Royal Society of Chemistry.
Symposium on "Pollution Monitoring".
Chairman: H. Fish. Speakers: P. G. Whitehead, C. Coombes, J. M. Parker, A. E. Hey, M. L. Richardson.
Scientific Societies Lecture Theatre, New Burlington Place (off Savile Row), London, W.1.
Contact: D. L. Miles, Hydrogeology Group, British Geological Survey, Wallingford, Oxon OX10 8BB.

21 November
BHS Midland Section.
"Operating surface water under drought conditions".
Birmingham University.

7 December
Scottish Hydrological Group.
"Floods in Scotland — a hydrological and geomorphic analysis" — Introduced by Dr A. Werrity and M. Acreman.
Royal Society Rooms, George Street, Edinburgh.

10 December
British Hydrological Society.
Annual General Meeting followed by a National Meeting on "Hydrological education and training in the 1980s".
University of Birmingham.

1985

9 January
Pennines Hydrological Group.
"The use of the WASSP — SIM model in hydraulic analysis for sewage rehabilitation" — Introduced by S. Roberts and G. Tatterson.
NWW Dawson House, Great Sankey, Warrington, Cheshire.

9 January
Institute of British Geographers.
Seminar on "The strategic implications of UK catchment research".
Speakers: T. Burt, G. Roberts, J. Stoner, P. Walsh.
Held as part of IBG Annual Conference, Leeds University.
Contact: Dr D. Kay, St. David's University College, Lampeter, Dyfed. 0570 422351.
(Further details above).

16 January
BHS National Meeting joint with the Hydrogeological Group of the Geological Society.
"Hydrological and hydrogeological aspects of river basin management".
Geological Society: London.

18 January
Scottish Hydrological Group.
"Acid Rain" — Introduced by a speaker from Solway RPB.
McCance No. 2 Lecture Theatre, University of Strathclyde, Glasgow.

5 February
BHS Southern Section jointly with IPHE (Metropolitan District).
"Airport drainage including the hydrological aspects" — Introduced by J. Stewart and F. J. Kaul.
Imperial College, Department of Civil Engineering.

8 March
Scottish Hydrological Group.
"The effects of upland management practices on water resources" — Introduced by R. E. Youngman.
Royal Society Rooms, George Street, Edinburgh.

11 March
BHS Southern Section.
"London Weather Radar".
Time and venue to be finalised.

20 March
Welsh Hydrological Group.
"Sewer flow analysis" — Introduced by H. H. Jones.
University College, Cardiff.

28 March
Pennines Hydrological Group and Historical Engineering Group.
"Reservoirs" — Introduced by N. Hoyle.

8 May
BHS National meeting joint with Welsh Hydrological Group and Institute of Biology.
"Management of Wetlands".
Wildfowl Trust, Slimbridge.

13 May
BHS Southern Section.
Afternoon visit to Thames Barrier.
Evening meeting on "Floods in London".

15 May
Pennines Hydrological Group.
Annual General Meeting followed by a discussion on "Floods resulting from dam failure".
Department of Civil Engineering, Sheffield.

June (date to be finalised)
BHS National Meeting.
"Modelling in flood plain planning".
Birmingham University.

Research Funding

J B Ellis
Centre for Urban Stormwater Pollution Research, Middlesex Polytechnic
Joint project with Madrid University on metal toxicity to treatment plant resulting from surface runoff from highway surfaces.
(British Council)

Collaborative work with Chalmers University, Gothenburg, on heavy metal speciation associated with urban runoff.
(Swedish Environmental Protection Board)

Prof P. C. Young — Envir. Sci. Lancaster
Aggregated dead zone model for transportation and dispersion in river systems. *(NERC)*

Dr C. M. Clapperton & Dr D. E. Sugden
Geography Leeds
Debris entrainment and release at the edge of the West Greenland ice sheet. *(NERC)*

Dr D. W. Knight — Civil Engineering Birmingham
Hydraulic analysis of channels with flood plains. *(NERC)*

Dr R. D. Hey — Climatic Research Unit East Anglia
Effect of vegetation on flow resistance. *(NERC)*

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