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* PRIVATISATION *

As many members will be only too aware, a White Paper on the Government's intention to transfer the Water Authorities of England and Wales to private ownership "as soon as possible" was presented to Parliament in early February.

In general, the White Paper maintains the principle of integrated river basin management of the whole water cycle, with the Authorities being privatised on the basis of the existing boundaries. However, it proposes that land drainage and flood protection shall be financed and co-ordinated through special public bodies which "will make the fullest use of the Water Service Public Limited Companies' expertise".

At the recent BHS committee meeting, the implications of the Government's proposals for privatisation were discussed, noting particularly the views expressed by the President in a letter sent to the government departments, a copy of which is presented below.

Dear Secretary of State,

re: Privatisation of the Water Authorities in England and Wales — Cmnd 9734

The British Hydrological Society was formed in 1983 to promote interest and scholarship in both scientific and applied aspects of hydrology and to foster the involvement of its Members in international activities. For this reason it has attracted a Membership of professional and otherwise learned people engaged in the study and practice of hydrological science and knowledge. The Society has a rapidly growing membership of just less than 500 which is drawn from a variety of occupations but principally those of research, teaching, water services industry and private consulting industry. It includes many senior and eminent people respected for their hydrological views and opinions the world over.

Having such a broad spectrum of scientific and occupational interest the Society's Membership is naturally interested in any proposed industrial change which will affect hydrological practice. It is therefore very interested in the recently published Government White Paper on Privatisation and especially those proposals relating to land drainage and flood protection (paragraphs 46 to 48) and by implication the management of water resources — Statutory Water Companies (paragraph 43).

May I firstly however express support for the declared intention of maintaining the principle of integrated river basin management. It is without doubt a rational principle and I believe it has been shown to work well since the water industry's last major reorganisation in 1974.

It naturally follows that I support also the statement in paragraph 46 that both land drainage and flood protection are an integral part of the unified system of river basin management. I was in consequence surprised to read the proposal to have the financing and co-ordination of land drainage and flood protection the responsibility of Special Public Bodies quite separate from Water Services Public Limited Companies.

The White Paper's reason for not vesting these functions in a private sector body is their non-commercial nature. The White Paper does not amplify the reason but I imagine it is referring to the problem of assessing appropriate amounts of financial contribution to be obtained from beneficiaries (for both capital development schemes and maintenance and regulatory work), and further to the difficulty of obtaining agreements with multiple beneficiaries for carrying out work especially when degrees of benefit received by beneficiaries are markedly different. These are difficult matters and would need to be overcome if commercial recharge is contemplated. Outline suggestions of the Government Green Paper "Financing and Administration of Land Drainage, Flood Prevention and Coast Protection in England and Wales — Cmnd 9449" did imply that was the intention. I am therefore left to wonder if the intention of the White Paper pre-empts deliberations for the Green Paper.

At any rate I do question if land drainage and flood protection work is any less commercial than say conservation work or maintenance or riverine fisheries to warrant their separate administration. It should be noted that determination of one of these matters invariably involves consideration of the others and equally noteworthy is the fact that current activity of the water industry in nature conservation is in large measure to do with river work (a major drive by the Nature Conservancy Council is to have Water Authorities carry out river corridor surveys wherever major land drainage and flood protection work is proposed). The need for very close liaison between these different interests argues for

corporate management; separate management should be avoided if it is possible.

However, administrative difficulties caused by separate administrative bodies may be overcome by the White Paper's compromise proposal that the Special Public Body will make the fullest possible use of WSPLC expertise, perhaps by employing them under contractual arrangements based on levels of service data. I envisage that these arrangements will have to be very special, and I doubt very much if protection of the public purse will be possible by the straightforward expedient of competitive tendering. The bond between WSPLCs and Special Public Bodies almost inevitably will be much stronger than the outlined proposal implies, as the following reasons suggest.

—Maintenance of rivers and river works requires materials, plant and labour. Economies in providing these are derived by the shared use of plant and labour in other water services work, (land drainage and flood protection work is seasonally affected). It would be a pity if the advantages of an integrated and flexible force of labour and plant developed by the Water Industry since 1974 should be lost by re-organisation.

—Control of flood waters in rivers can and does involve the use of multi-functional facilities. An example is the planned and operational use of reservoir "space" to mitigate downstream flood conditions. Such space may add to risk of water supply shortfall in dry seasons, to greater costs of water resources management, and even to reducing revenue from the sale of locally generated hydro-electric power. It has therefore got to be planned very carefully and clear agreements on cost allocations would be needed if different responsibilities existed.

—Flood warning is an operational service provided currently by Water Authorities. Modern methods depend not only upon expertise but also on good observation networks, telemetry communications and even radar. Systems are sophisticated and expensive and they need to be maintained. In most cases they are an integral part of a multifunctional facility for remote control and information. It is difficult to envisage therefore how direct service responsibility involving telemetry communications could be disaggregrated (should the Special Public Body ever feel the need so to do).

—Provision of a land drainage and flood protection service for scheme design and operation and for general maintenance work requires a good database. A high proportion of the information required derives from well established hydrometric networks (rainfall, river levels/flows) which have asset value nationally totalling many millions of pounds.

The financial value of these assets is greatly enhanced by the value of information they provide in giving historical perspective to events and thereby in evaluating risks and in planning, design and operation. They need to be maintained and operated, and data from them need to be processed and archived systematically. However, hydrometric networks provide information for a variety of uses such as resource planning, routine river regulation, abstraction controls, pollution prevention, fisheries and so on. Separating financial and co-ordinating responsibilities for land drainage and flood protection would require careful consideration of shared values of data and also of how future networks may be determined and managed.

A further matter to be considered is the national interest in environmental information. A national water data archive exists and it depends upon the provision of data by "gauging" authorities. It is maintained by the Institute of Hydrology and the British Geological Survey. Repeal of parts of the 1963 Water Resources Act by the 1973 Water Act removed from the water industry an obligation to record hydrology for purposes of regional and national archive. Provision of data is currently dependent therefore upon the goodwill of the industry. I believe that voluntary provision of data of national importance to be an undesirable feature especially in the context of a private industry and I would recommend that opportunity be taken in any new legislation to make special arrangements for national data interests.

Paragraph 43 alludes to organisation for future water supply and especially water resources management. Integrated river basin management is very important when considering the development and control of a region's water resources. Within the framework of a single water undertaking and from a viewpoint of efficient and economic management of regional resources it is important to have laid-down control policies and strategy designed to minimise risks to the security of water supply and to avoid unnecessary operational expenditure.

When however a river basin's water resources or regional water resources are shared by two or more major water undertakings, or when, as in the case of groundwaters, catchment divides are not the major criteria by which potential interest in sources stand to be determined, the establishment of development and control policies is even more important. It therefore follows that if constitutional links between currently existing water companies and the new WSPLCs are not to exist determination of clear and agreed future resource control policies should be obtained preferably before implementation of new legislation. Under the present organisational arrangements control and development policies have been worked out, but under newly privatised arrangements it may be found that commercial pressures may be set against the continuance of these simply to achieve parochial economy as distinct from river basin or regional economy.

In all of these hydrological and environmental issues I surmise that the Director General and the new consumer bodies will play important parts. It is not clear in what way or to what extent if any the Special Public Body for land drainage and flood protection will relate to the Director General and the consumer body. It is possible to envisage several arrangements. In view of my foregoing observations I am drawn to the view of yet having land drainage and flood protection as part of the WSPLC and the consumer body taking an active interest in this function as well as all other environmental riverine issues as proposed. Such an arrangement would seem to be the tidier and would probably lead to less ambiguous administration.

I hope you find these few observations of interest and constructive and I would be happy to seek the views of Society Members if there are any matters of hydrological interest upon which you would wish a more general opinion.

Yours sincerely,
P. Johnson

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New Members

We welcome the following new members to the Society:

T. HARRISON ..... Assistant Resources Officer, Severn Trent Water Authority
R.F. PITCHER ..... Dep. Chairman, Armfield Technical
V. POURSHARIATI ..... Research Graduate, Imperial College

NEWS FROM MEMBERS

Peter Walsh has advised us that nearly all the appointments in his Hydrological and Scientific Applications Section at NWWA have now been made. **Geoff Noonan** is the Senior Hydrometric Engineer and he is assisted by **Alan Johnston** and **Ray Rushton** for hydrometry in the North and South of the region, and by **Brian Repton** for Licensing and Flood Warning. **Tony Lewis** is responsible for Data and Applications (including the Water Archive) and **Bob Kinley** for Statistics and Operational Research. The Senior Hydrologist is **Mike Knowles** who is assisted by **Ian Pearse** and **Susan Walker.**

Dave Archer has returned to Northumbrian Water after a year's secondment with **Howard Humphreys** in Kenya. Apart from his duties at NW, he is now working on a private project researching the history of flooding in Northumbria and the incorporation of historic data in flood risk assessment. For this project he has received support from the Leverhulme Trust which other members might note as a potential source of limited funding.

Dave also sends us the following snippet.

"Members who have worked overseas will be aware of the extent to which discharge records in many countries are dependent on an army of daily staff gauge readers. They forward their monthly returns with a doggedness which is not matched by their scrupulousness in actually visiting the gauge or their skill in reading it correctly. Many a structure has been designed on very dodgy data. The following is a verbatim extract from the files, where the hydrometric supervisor had obviously gone to some pains to put the matter right.

'The water reader on reading a gauge height say 0.54 m enters it as 0.66 m. This then explains why instead of counting the 2nd digits after the decimal of a meter downwards from the 1st digit after the immediate stage, then subtracting the 2nd digits from the immediate first digit above the stage to get the actual G.Ht., he enters the 1st digit after the decimal then the second digits countered downwards to the stage, instead of *substracting the 2nd digit from the *presinding 1st digit. Hence where the stage is, say, 0.26 m he reads as 0.34 m.'"

*Spelling as in original.

RESOURCES

A river corridor study for the North Tyne River has been approved by Northumbrian Water principally to study the effects of HEP releases from Kielder on the ecology and morphology of the river. The study will be jointly undertaken by the Authority, the University of Newcastle, and the Nature Conservancy.

Thames Water took over responsibility for the rivers operations of the GLC on 1st April. The hydrometric field staff are located at Waltham Cross in Technology and Development. The responsibility for flood warning has been transferred to Rivers Division with staff located in London and Reading. Operation of the Thames Barrier has been transferred, together with the staff, to Rivers Division.

GROUNDWATER

Thames Water are currently evaluating the viability of using automated pumping tests. The Wimpey Geoconsult Pump Test Data Aquisition System (PTDAS) is currently being looked at. This system monitors a range of parameters including pump discharge, water levels in the pumped well and observation wells, atmospheric pressure, rainfall events, temperature, electrical conductivity, pH and eH. The PTDAS has sufficient battery power to allow unattended operation for about 10 days. Data is automatically stored, at specified time intervals, onto the on-site computer's memory and onto discs after each measurement is taken.

Data from the field will be transferred directly onto a Hewlett Packard 310 Series microcomputer at TWA. Software will be developed to allow the data to be used for plotting and pumping test analysis and as input to existing radial flow model programmes.

FLOW FORECASTING

Work is in progress in Thames Water, writes **Cathy Glenny**, on a flow forecasting system using a Hewlett Packard 310 desktop computer. The system retrieves flow, level and rainfall data from the Ferranti Argus telemetry computer, stores this in a 10-day rolling archive and uses a catchment model developed by Thames Water to generate forecast flows.

The system is being developed for the River Thames at Windsor. Further enhancements will include extension to other sites, the use of radar subcatchment rainfall and a procedure for correcting errors in the generated flows.

A new flow data processing system is being developed. The new system is being written in Basic on a Hewlett Packard 310 machine. The HP will interface with all possible source of data, including a digitiser (for use with Munro level charts), Sarasota, Technolog and DRS loggers, 16 track punch tape reader, a Ferranti Argus telemetry computer and a Dynamic Logic telemetry master station. Data from all of these sources will be converted into a uniform format so that only one suite of data processing programs is required. The HP will provide colour graphics facilities to assist the process of data validation. The system will be operational by the end of the summer. It will be operated by both the Reading and the Waltham Cross hydrometric groups.

DATA MATTERS

The Water Resources Development Section of Thames Water has just obtained a "Robertson Research Geolog 1000" *digital Geophysical logging system* for boreholes.

Services include:

- Fluid temperature and differential temperature logs.
- Fluid conductivity and differential conductivity logs.
- Natural gamma ray log.
- Caliper log.
- Normal electric logs.
- Guard electrode log.
- Flow meter log.

The system is installed in a County 110 Land Rover station wagon.

Weather radar information, received for use particularly in flood warning, is now being processed by a package designed in-house to run on a BBC Micro alone, writes **Nell Whiter** of South West Water. For details of this and other related developments, contact Alan Raflet or Richard Horrocks in the Land Drainage Department, on Exeter 219666.

MAPPING

Following the successful completion of the first contract to provide up-to-date geological mapping of the southern half of the Cirencester geological sheet no. 235, the Water Resources Section of Thames Water has negotiated a second contract with the British Geological Survey to carry out geological mapping of about 50% of the Thames geological sheet no. 237. There are no published maps currently available for this sheet and it represents one of the most needed maps in the British Isles. Modern geological maps on 1:10,000 and 1:50,000 will be produced.

As with the Cirencester sheet it is expected that the entire sheet will be mapped and published in due course.

IH has been awarded a contract with the DoE for Northern Ireland whereby IH is to provide estimate for average flow and low flows for every stretch of the NI river network.

And finally . . .

Not really news from members, but one of our regional network draws our attention to a consultation paper from the DoE and Welsh Office entitled "Water and Sewerage Law". Obviously this is mainly concerned with tidying up the existing legislation and sorting out some of the anomalies but there are also some profound implications for water resources. For example, it is proposed that extractions of anything less than 20 cubic metres a day will not be licensed, merely "registered" and that everything above this volume will be licensable — even where this is not the case at present.

Water Resource Implications of UK Irrigation

BHS Southern Section Meeting
3 February 1986

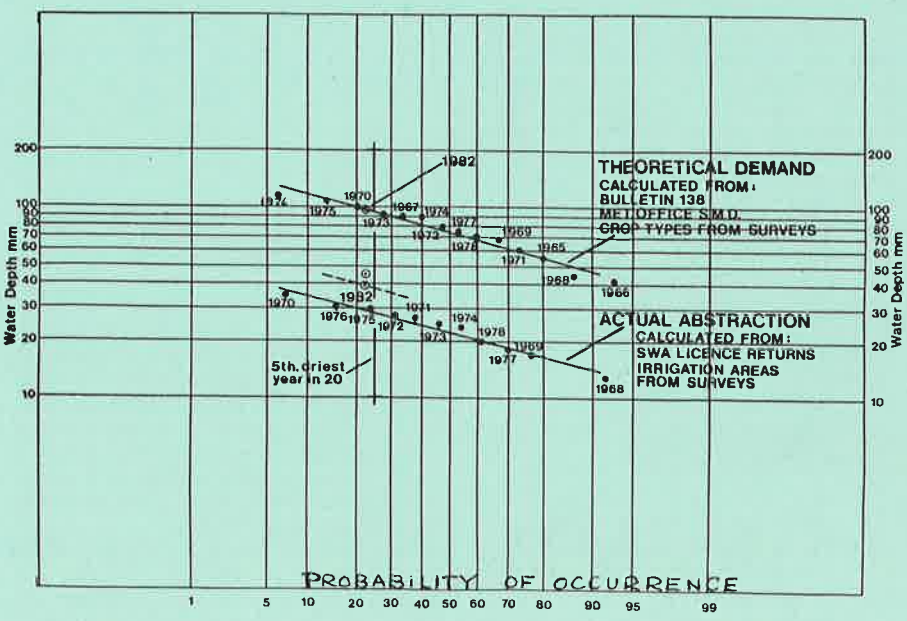
In the week that the EEC announced food surpluses of £4 billion and newspaper headlines declared "Farm prices falling" 45 members and guests, many from outside the region, eagerly attended the meeting at Imperial College to hear what C.J.N. Cotton (Southern Water Authority) and M.G. Kay (Silsoe College) had to say in particular about forecasting demand for spray irrigation.

Chris Cotton introduced the Water Authority viewpoint with the 1963 Water Resources Act, which had revolutionised the approach to water abstraction since previously "riparian rights" had not covered spray irrigation. Irrigators were now protected, but run of river licences had become difficult to obtain. In Kent and Sussex 14% of demand for outdoor crops was in fact met from public water supply mains. Water authorities, in applying minimum acceptable flow criteria, have had either to use physical controls at intakes or to set complicated abstraction rules. This had forced farmers into investment in off-stream storage, which was best developed by corporate schemes. Catchment policies must be clearly defined and defensible in court. A sophisticated pumping scheme in the fertile marsh area of East Kent bordering the River Stour was described which had controlled tidal salinity and allowed an expansion from pasture to arable crops. In general, growers had become more discriminating, utilising their licences to extend their cultivated acreage, the length of the season, or the variety of their crops. Some had retained their licences as an insurance or as a valuable asset attached to their land. Charging schemes, in particular summer and winter differentials, although substantially increased, seemed to have had little influence, since water charges formed a small proportion of the total costs.

The only reliable information on types and areas of crops irrigated was contained in the MAFF censuses, which appeared to show a steady rise in the "area irrigated in a dry season in England and Wales" from 80,000 hectares in 1974 to about 170,000 hectares in 1984, but evidence suggested that farmers applied less water than the optimum dictated by soil moisture deficit. A statistical analysis carried out by SWA (see Figure) indicated that the proportion of the theoretical quantity that was actually applied had remained constant at 30%. The Advisory Committee on Agriculture and Horticulture in England and Wales (ACAH, 1980) in their report on "Water for Agriculture: Future Needs" had forecast that spray irrigation demand in 2000 AD would be four times the demand in 1977. This was based on an anticipated progression from 50% to 80% of theoretical need and an expected increase of 2½ times in the irrigated area. A National Water Council Working Group has questioned this forecast and it was hoped that a survey of the 1984 and 1986 returns would give a more reliable estimate. Chris Cotton ended by suggesting some improvements: legislation to place fish farming for the table and trickle irrigation under licensing control; the introduction of trading in unused licences by variations and compensation payments; better data on water use and crop agronomy; and a review of the licensing system to try to streamline procedures.

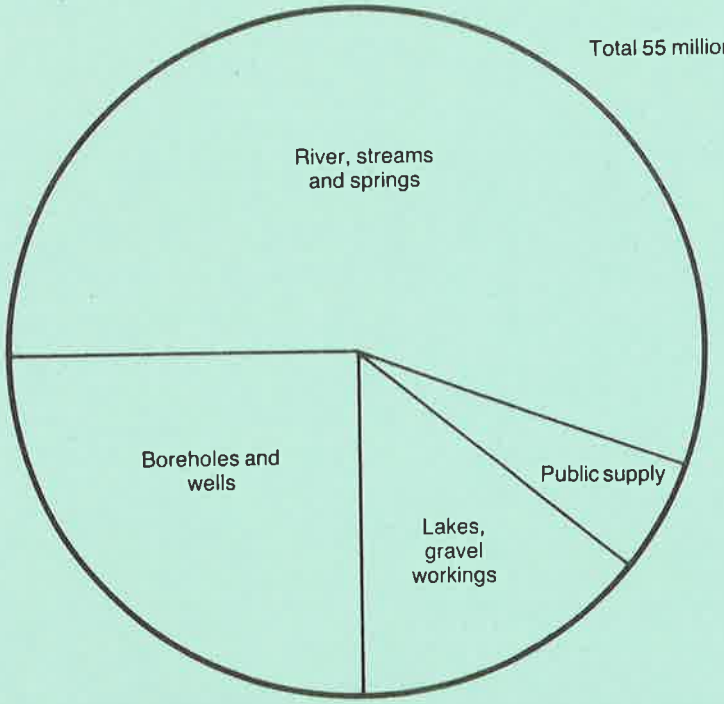
Melvin Kay speaking as an engineer on behalf of farmers quoted a country aphorism "When a drought happens, it happens fast". This explained why irrigation often started too late. No one in the audience was prepared to admit publicly to being a farmer but an ex-President of the Society was overheard afterward explaining earnestly how to grow potatoes! Potatoes were mentioned as a popular crop with 30,000 acres under supplementary irrigation in the UK. (One wondered what had happened to the Irish potato and speculated that its absence might be an example of the distortions created by EEC subsidies, a matter raised later in the discussion by **Brian Flynn**).

Other crops irrigated were sugar beet and apples, in which skin cracking could be reduced by judicious water applications. More than 103,000 hectares of land were irrigated in the UK using 55 × 10^6 m^3 of water. It was seen as a means of improving productivity as a response to market forces, which rewarded quality, uniformity, regularity and reliability of supply. Irrigation removed one level of



Spray irrigation of crops in the open in Kent and Sussex River and Water Divisions

uncertainty in specialised areas. The potential for growth had seemed enormous, but the initial costs of setting up and disenchantment with the early equipment, largely rotary sprinklers, had led to a decline in irrigation during the 70s.



Sources of water used for irrigation.



Hose-reel irrigator fitted with boom system.



Hose-reel irrigator fitted with rain-gun irrigating a sugar beet crop.

The drought of 1976 and the EEC stabilisation of farm prices had brought renewed interest as manifested by the growth of the UK Irrigation Association to 800 members, but it had not resulted in universal expansion.

Present practice concentrated mainly on root crops on clay soils, and was production rather than energy oriented. Irrigation should be extended to grass crops on easily cultivated sandy soils. This would be dependent on greater water use efficiency. Half the irrigation in the country was in East Anglia where water was the limiting factor. Yet the planning process was often haphazard. Despite the variability of rainfall, soils, and crop species many schemes still used rule of thumb application rates such as one inch every ten days. However, modern advances in equipment gave hope for the future.

Melvin Kay then showed a series of slides to illustrate such things as rain guns, centre pivots, dropped pivots, water placement by fixed jets and the potential for aerial photography. He finished by saying that there was a great deal of misunderstanding about how much water to apply and when to apply it. Detailed planning and investigation of soil, water and fertilizers as a complete system should be encouraged.

Howard Wheater, in opening the discussion as chairman of the meeting, referred to the actual abstraction of 30% of the theoretical demand and suggested that perhaps only 20% finally reached the plant. **Rodney Armster** discussed systems of drainage and Chris Cotton added that by controlling soil temperatures the cultivator was able to get onto the ground sooner. Irrigation in the UK was essentially supplementary and behaviour analysis was required to assess the practical value of scientific advice. As **Mike Mansell-Moullin** pointed out, rainfall in Britain was difficult to predict so there were good economic reasons for unscientific scheduling. Other problems were greater. **Gerry Sheriff** raised the question of criteria for failure, such as water shortage one year in five; but purchase of equipment which was not used could also constitute "failure". The key to reliability was adequate storage and co-operation between farmers. **John Gowing** and **David Evans** then expressed concern about sub-irrigation, which in Anglia was three times as much as spray irrigation, difficult to control and circumvented licensing procedures. The use of helicopters and light aircraft was recommended for various control problems. Doubt was cast on the 30% ratio in very dry years; for instance 1976 had been a test year but there had been no restriction on spray irrigation. Finally **Peter Drake** concentrated attention on the vital subject of demand forecasts. The total spectrum of UK demand was extremely complex and bound up with the overall economics of farming. Perhaps more research would give a better picture of the market variables. **William Bradford** asked for advice on the analysis of 10-15 years of irrigation data which was available in Severn Trent. **Simon Hall** had noted that farmers now asked for more water per hectare. The two principal speakers could not, however, be persuaded to refine their forecasts!

Terence Davis

Hydrological Data Management in the UK

BHS National Meeting
17 February 1986

This meeting continued many of the themes discussed at the BHS meeting of 17th April 1985 and contained some presentations which were given to the invited audience at the IH on 1st October 1985 to celebrate the 50th anniversary of the national collection of river flow data. Speakers were invited to represent all aspects of the hydrological cycle and the recent publication of the White Paper (Cmnd 9734) concerning future privatisation within the water industry was expected to add pith to discussion.

The first session was chaired by **John Rodda** (IH) who invited speakers to conjure up a significant hydrological association for 17th February. **Reg Herschey** wandered through the historical provocations for the setting up of the IWS, the result of considerable mole work at the Public Records Office. Systematic rainfall measurements commenced in 1729; were formalised in 1860 with the British Rainfall Organisation, and subsumed into the Met. Office in 1912. The Geological Society was founded in 1807, and the survey in 1835.

Why the 100-year wait for the IWS? Periodical droughts spurred demands for a resource-based Survey in 1861, and eventually, the BAAS set up a committee in 1932 for this purpose. The committee reported in 1933, and, in conjunction with the ICE, made an approach to government in 1934.

Reg then diverted from his sleuthing to give a brief history of the river flow archive's stewards from the IWS (1935-39, 46-52), the SWS (1955-64), the WRB (1964-74), WDU (1974-82) and, currently, the IH, with details of "yearbook" -like publications. These data started from 1st October 1935 (1938). The advent of computer data processing with the WDU saw a change in style, whereby raw data were not published, merely a list of stations, in anticipation that computer retrieval would service the need. This Utopian philosophy led to year books becoming further into arrears until there was an eight year lag for 1974. IH has a policy of returning to annual publications one year in arrears. Reg returned to the political dimension surrounding the birth of the Survey, reading from letters and minutes between civil servants and ministers. One could almost conjure a "Yes Minister" script from the material, albeit in the ponderous tones of 1934! We have Ramsay MacDonald sent to Scotland to holiday by his doctor and Sir Hilton Young (Minister of Health) charged with sorting out the case. The DSIR (forerunner of NERC) showed interest, but the MOH was cool, following the deputation by the BAAS and ICE to the minister. Some deeper hidden motivation appeared to power the progress of the Survey and the minutes included gems like: "I think that we may have some difficulty with the DSIR; our arrangements may very well be too practical to please the scientists and if it were to be so we must see what could be done to meet them. We do not want any more trouble with the British Association."; and "The sensible course is for the *Scotch* (!) to come in on the committee . . ."; and "We need not be over careful if the Scots come in or not. There is something to be said for them acting separately; it is a long way from Edinburgh . . .". The Survey Committee (including the Scots!) was set up on 1st January 1935. Reg floated the idea that Capt. Maclean in Scotland had "nobbled" the Prime Minister whilst the latter was holidaying in Lossiemouth; civil servants, he thought, would be unlikely to have acted with such speed. In reply to questions, he was unaware that the Royal Society Hydrology Sub-Committee had pressurised government during the Survey's hiatus in 1952-5. Regarding the IH published year-books, he thought that the DOE (the funder) and the water industry were co-operative in their production and welcomed the publication of daily data.

The next, joint, presentation was by **Mike Lowing** and **Terry Marsh** (both IH). Mike outlined the reasons why the NERC would wish to take on the flow archive; thinking that the IH could do it better, provide better validation and widen the scope of publications. Further, an improved dialogue with measuring authorities would benefit the IH by retaining the perspective of the operating world. He outlined the representational and liaisive structure which had been set up at the IH and that the expertise now developing may have benefits in offering advice to authorities on the standardisation of data processing and storage regimes. He described the gamut of liaison that this entailed, giving emphasis to the appreciation of station ratings and detailing interest in other data, more appropriate for event analysis.

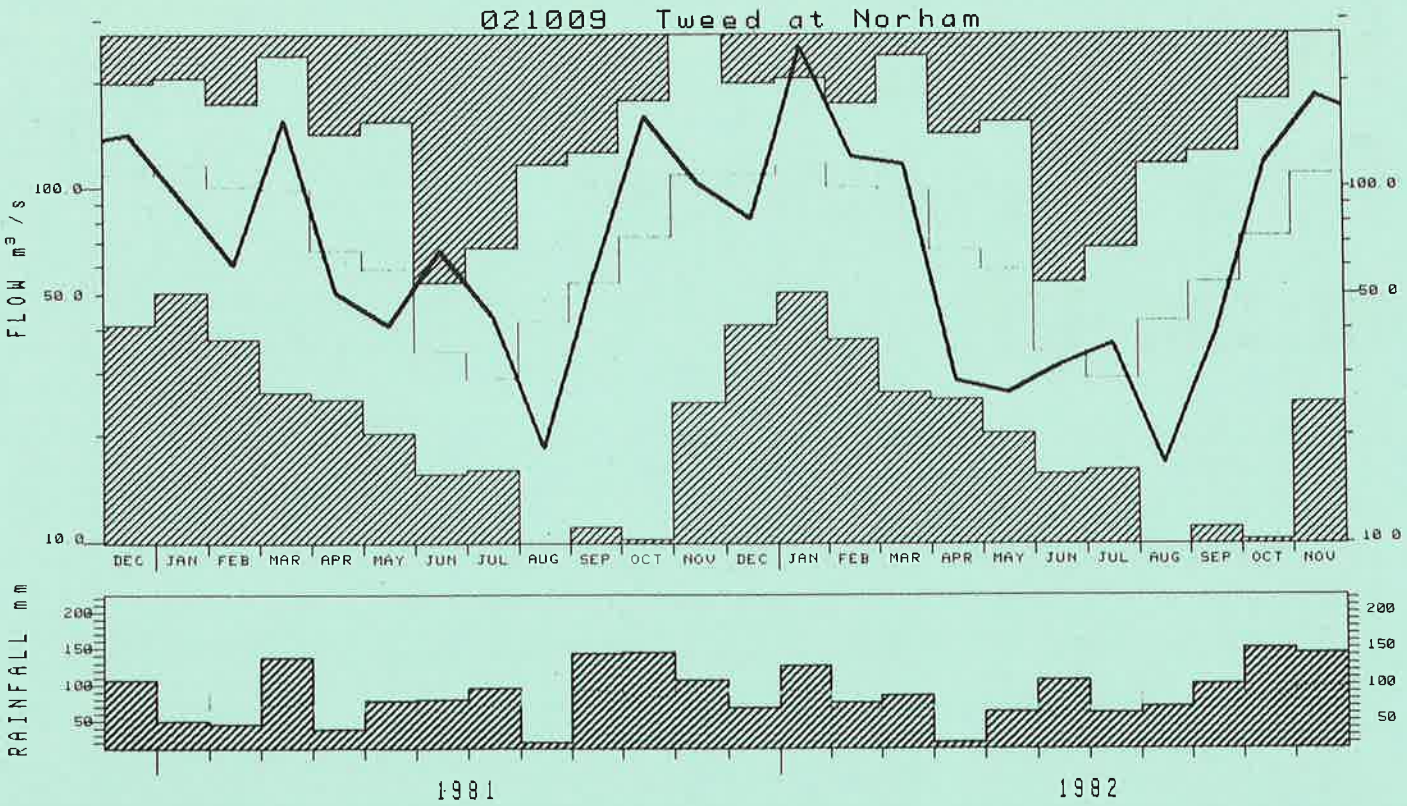
Back in the office, comprehensive gauging station files are held along with all the old data records now stored on microfiche to assist in historical validation. The archive system had a comprehensive set of updating, validating and retrieval facilities; most data was supplied on magnetic tape. Extensive rainfall records were also kept; both daily and shorter time bases. The river flow archive was now part of a wider data base, designed to allow easier access to a range of data useful for resource based or extreme event studies.

More than £1m had been spent since its inception as a computer-based archive on its development; probably a greater sum was expended annually on the collection of the data by gauging agencies. An estimate of the replacement cost of the network was in excess of £40m. Wasn't it reasonable, asked Terry Marsh, that a proportion of this sum should be spent on validating data and improving accessibility to a sound archive? IH's practice is to validate on the one hand and flag on the other. The most illuminating feature of his presentation was the description of a series of hydrographs photographed from a graphics terminal screen. These showed part of the record displayed against the historical max., min., and mean and the associated catchment rainfall; the sympathetic behaviour of four superimposed stations on the Tweed; and comparisons of low flow sequences within a single record. The plots could be zoomed in on or migrated across the screen when using the terminal, forming a powerful and rapid validation tool. He then described the features of the Hydrological Data:UK series (two yearbooks were circulated among the audience) emphasising its broader scope than hitherto, with the inclusion of weather and groundwater reviews and the intention, using Terry's split infinitive, to better inform the public on the location and availability of the flow archive. (See *Circulation* November 1985).

Discussion centred on the national archive in a privatised industry setting. Speculation about the operation of gauging by the PLC's as agencies and the centralisation of local archives was juggled with, but the presenters wished the status quo to continue and hoped that the legislation would still allow access free of charge to the data. There were no plans for the IH to set up 15 min stage archives or a comprehensive collection from rain recorders.

The President, **Phil Johnson** (NWA), opened the afternoon session by referring to some of the proposals in the White Paper and how the roles of the existing Water Companies and the future PLCs would intertwine; similarly the new "Special Public Bodies" charged with land drainage and flood protection. He urged the society to consider how to influence or comment on the partitioning of data collection and archiving.

Frank Singleton (MO) gave a rapid but comprehensive account of the variety of data collected, quality controlled and archived by the Met. Office. He was supported by an excellent pre-circulated synopsis (Ref. LF/Mo3). There were a great many summary numbers involved in the description of the four principal data



24-month hydrograph superimposed upon mean monthly max. and min. flows for the period of record.

sources: from the synoptic, climatological and daily rainfall networks, and from continuous or event recorders. Numbers which may cause surprise are the >2200 stations operating in 1880; in 1982 there were 1985 rainfall stations which were operating in 1951, and 440 stations with a >80 year history. 150 climate stations have a >30 year history and 42 >85 years! A considerable volume of data still enters the MO by keypunching. Quality control is a hierarchical system, commencing with checking the hourly data from synoptic sites for internal consistency and against their daily summaries, then merging with the daily recorded data and checking again for consistency via near neighbourliness. Although validation is mainly computer based, human arbitration is final. For the future, continual refinements to processing were anticipated and faster and more automated data aquistion welcomed. The MO was keen to enhance its capture of event-based data and hoped that the industry could co-operate. He ended by outlining an interactive database, FARMAID, which allowed applied forecasting for agricultural purposes.

Brian May represented the high-tech arm of the MO by introducing PARAGON, a convoluted acronym for a process synthesising the data from the English weather radars and the gauged network. The system has two sets of rainfall estimates, both as 5 km grid square averages, one in near real time (i.e. a few hours) and one after a few months. The two outputs interlink via common data sets as time progresses. An information note from Met. 03 was pre-circulated. The two routes followed a similar processing sequence in first accounting for fixed reflections, shadowing effects, anti-cyclonic weather conditions (anaprop) and second by the adjustment of the data by reference to a sparse gauged network of the synoptic sites. The data from the five radars are then composited (i.e. the overlaps removed). More leisurely adjustments were made when the full gauged network was available. Retrievals from the system were described. Discussion centred on whether the MO was satisfied with the estimates of rainfall profiles at varying altitudes and their treatment of snow. Frank was not fully satisfied about altitudinal variation, but said the MO would need recording gauges at intervals of 2-3 km to be so. Radar should be of help, although its resolution was not all that could be desired. Problems in assimilating data from recording gauges centred on the MO's desire for a check gauge; not necessarily critical for hydrologists who were interested in recording gauges as a means of distributing daily falls. Many short term studies used event based rainfalls; were the MO interested in these data? FS said the desire of the MO was for continuous records from sites verified by check gauges. Snow was handled only with difficulty, but efforts were being made to refine the measurement techniques. Brian May thought that radar was not the complete answer, but hoped that implementation of automatic recognition of bright band reflections would improve estimation.

Rick Brassington (NWWA) was the representative for the groundwater component, his "Cinderella" of the hydrological cycle. The data needs for g-w hydrology are most catholic and he would need access to the earlier components, as well as those particular to g-w. The recording of regular and widespread g-w levels were the result of the 1963 Act, subsequently many observation wells were sunk and other boreholes evaluated for that purpose. Life was not easy for the g-w hydrologist, he assured us, as he ran through a catalogue of cautions for interpreting g-w level data. For example, instantaneous water levels could be "standardised" by appreciation of interference effects, whether due to barometric pressures or a position in a pumping/recovery cycle, but it seems that such routine standardisation is not viewed in the same light as converting data to aOD levels. More esoteric effects, such as intra-formational variation and degree of borehole penetration almost had the audience believing we should give up dipping!

The variety of different data sources the g-w hydrologist uses may be obtainable by utilising the systems of the data gatherers; of the g-w specific data, he spoke of the separation of each data processing and storage system because they were different, citing geophysical, licensing and pumping test data as examples. He recommended caution in embracing computer systems; more important to tailor your storage and retrievals not to overestimate the accuracy and information inferred in the data. Discussion reflected this note of caution; whether in dealing with "general" values of S and T or in problems relating to aquifer chemistry, three items were repeated: individual cases merited individual study, modelling may only be of limited use, and the volume of data to be stored with confidence may be low and not deserving of machine storage.

The last session was chaired by the Secretary, **Mike Hall**. These were to be contributions about regional, rather than national, systems. **Alec Willis** (Somerset Div. Wessex) charted the history and logic behind the development of his Division's

hydrometric data collection. Ever pragmatic, Alec described the impetuses to move to modern technology for the Somerset system were the cost of installing mains electricity at a gauging station and the fortuitous arrangements of stands at the 1982 IASH symposium. The system had progressed to shaft encoders over stilling wells, with battery powered loggers and PSTN linked telemetry. At Bridgwater an autodial modem and a 16 bit microcomputer handled the interrogation, validation (including hydrograph inspection) and storage onto floppy disc. A printer and a table-top plotter completed the hardware. At the time seven stations were being operated with a further six planned by 1st April 1986. A "menu-driven front-end" was an enhancement, Alec commented wryly, that was essential as he couldn't attend professional meetings whilst being the only driver! The system seemed nicely tuned to the scale of operation; Alec claimed data capture of 99% over the 2,400 days of operation, together with the benefits of real-time access. A useful hand-out was provided with details of costs.

Bob Sargent (FRPB) was in the unenviable position of representing the whole of Scottish hydrometry, and, with as much tact as he could muster, decided to present two disparate approaches; that of his own RPB, the Forth, and that of the Tay. The Scottish water industry was differently organised to that in England and Wales, as the prime function of the RPB s was pollution control. However, the RPB's are now recognised as the hydrometric agencies in Scotland and all Central Government gauges have been ceded to them. The RPBs differed widely in size, communications, topography and financial resources; thus the FRPB had a budget in 1984 of £1.24m and an area of 4,655 km^2, and the Tay, £0.32m and 8,710 km^2. The FRPB had a gauging network of some 60 gauges, covering main rivers and most tributaries, with hardware similar to Alec's and with 16 linked by telemetry. Further, telemetered and solid state logged raingauges were also supported, some of which were incorporated into three flood warning schemes. Computers were widely used in quality control and data validation, although the principal route was through hydrograph inspection and near neighbour comparison. FRPB may be summarised as a high budget, high tech, rapid dissemination authority. In comparison the Tay board was mainly chart recorder based and had no solid state loggers; its single office was at one end of a large catchment area so travelling costs were high; processing was labour intensive, by chart digitising and micro based conversion to flows. As there were many shifting controls and rating changes, TRPB preferred to produce their flows on a yearly basis when all the information was available for comparison. They ran a few autographic raingauges and had a substantial daily read network. Bob chose to compare costs for the two approaches on the basis of % of budget spent on hydrometry and the per capita hydrometric "rate". In both cases the FRPB was marginally cheaper and Bob thought that the new technology was sufficiently reliable and cheap to prove economically attractive compared with traditional methods.

Richard Wood (STWA), now having responsibility for the provision of technical information within his authority, was intent on introducing a wider perspective to data usage than inferred by clean water hydrometry. He believed the fund of expertise residing in the hydrological sections of authorities relating to data capture, processing and archiving, real-time data collection, and modelling was unmatched in other areas such as water quality, distribution and sewerage. Not only could these areas benefit by the adoption of some of the techniques, but the end user of data would benefit from the marrying of varying data types in an organised fashion and in the future this would be essential for operational management. He emphasised that real-time data had the greatest worth to an authority, as well as showing economies in data capture. Richard outlined the history of real time data collection in STWA, with its change of emphasis from being allied purely to flood forecasting, to one where they hoped to have historical data collection and real time data needs serviced by the same scanning and processing system. The system would have the capacity to poll up to 200 outstations; a separate micro-computer would handle up to 80 recording raingauges and a large number of water quality interrogations. He illustrated the deficiencies implied by the different data sampling methods for quality and flow by reference to diurnal fluctuations in the River Tame.

The wind-up discussion covered whether the scattered development of new technology in the UK compared ill with the systematic, functional specification produced by the USGS as the AHDAS. Those on the platform thought not; experimentation had refined the range of kit down to those which were reliable and effective — reflected in the similarity of what was in use in the authorities. The problem of continuing justification of hydrometry in the face of unsympathetic accountants, especially after privatisation, was aired; real time data collection used in a co-ordinated fashion for operational control over abstraction, supply and sewerage was the key; historical data would then be a cheap adjunct. The lack of outside bodies with clout to put the case for establishing national or regional data sets was regretted and the Society was urged to advise in this field. The difficulties in improving the performance of quality monitoring were touched on; the reliability and the reluctance to use real time determirand probes were hindrances, as was the obligation for post sampling analyses — in the case of the STWA such analyses were costing £4,000 per day. Designing the hydrometric and the quality systems with a philosophy of interaction would allow these costs to be supported better.

Martin Lees

FLOOD PATROL IN NAMIBIA

Have you ever felt like getting dirty, soaked to the skin, exhausted from lack of sleep and working more overtime hours in one week than most people's standard working week? If so, then the Hydrology Division of the Department of Water Affairs in Namibia as well as the "A-Team" needs you, for the above constitute the pleasurable highlights of Flood Patrol in Namibia.

Flood Patrol was conceived about four years ago when the Division found that instead of just having sufficient field staff to service and maintain the hydrological network, it actually had Hydrologists to spare who thought that the idea of roaming around the country, chasing floods might be quite exciting. It involves teams of two Hydrologists (usually) who are "on call" and may be dispatched to any part of the country where useful observations and measurements can be made of rivers in flood. The motivating factor behind this, is that in spite of a reasonable length of flow record at many gauging stations (say 15 years), comparatively few observations have been made of flow at the stations over a range of discharges. This is partly due to the annual flow duration characteristics of rivers in a semi-arid environment which result in 20-40 days of flow on average each year and partly due to the low frequency of station visits occasioned by the large distances involved and difficult terrain. The benefits of Flood Patrol have already manifested themselves in improvements



View of the "problem" sandbank at Etemba on the Omaruru River following a flood of 1.9 m (240 m^3/s).

and extensions to ratings at a number of stations and the discovery of unexpected flow conditions at specific sites.

Let us picture the scene a little better. It is a Monday morning in the Hydrology offices in Windhoek and the weekly briefing of Hydrologists is taking place. The alleged rainy season is up to its normal tricks again and having failed to manifest much more than "dust settling showers" until the end of January, it has suddenly burst upon the scene, bringing many major rivers down in flood for the first time in the season. Some have even pushed through the Namib Desert and into the Atlantic. Not surprisingly, this has happened over a weekend. The Head of Hydrology has spent a busy weekend on the telephone trying to piece the events together.

It transpires that all of the action has taken place in the part of the gauging network allocated to myself, and before long, my ever gallant colleagues are keenly suggesting that I should be sent out, seeing as it is my area and at least earn my recent promotion.

Two hours later we were fully mobilised. That means a four-wheel drive vehicle (essential even in the dry season) loaded with velocity gauging equipment, surveying equipment, radio, sample bottles, floats, tent, tools, about a week's supply of food and a couple of beers. After a final up-date on the latest flood information we departed vaguely in the direction of where it had all happened over the weekend, and wondered whether this would be another wild goose chase.

About four hours after leaving Windhoek we reached our first destination — a gauging station called Etemba on the Omaruru River. This is one of our major stations comprising a weir with double instrumentation and a permanently installed cableway for velocity gaugings. On arrival at the station the river was flowing at a depth of 0.80 m according to the left-bank GP (gauge plate) and 0.39 m according to that on the right bank where the recorder shafts are located. This curious state of affairs is the result of the intermittent appearance of a sandbank just upstream of the weir on the right bank. It was first observed during a Flood Patrol trip in 1982 a mere 15 years after the station had been opened. After a number of velocity gaugings both with and without a sandbank it has been possible to compile a number of ratings for the various situations. Although our knowledge of the specific problem has increased, we are at this stage no closer to a model which can predict when the sandbank will appear or disappear again. However, the lesson of Etemba came over loud and clear, namely that a pen trace on a chart may not be all that it appears to be and the justification for Flood Patrol was further enhanced.

Within an hour of arrival at the station, the level (on both banks) began to rise. We swung into action and tried to remember all the tricks of cableway gauging. Just after we had managed to grope our way around the Ott winch, the flood began to subside — almost as rapidly as it had risen. The gauging was a bit of a disappointment, but at least we'd warmed up.

This being the first night of our trip, we were still keen and so set an hourly watch — Jon until 0100 h and myself from 0200 h onwards. All was pretty quiet until at 0400 h, the noise of rushing water awoke me before the alarm. Without a moment's hesitation the recorders were checked and as the flood peaked at 1.9 m we began a cableway gauging. "If they could see us *now*", we said as we tried to reassure ourselves of our sanity! More gaugings followed on the recession until the lure of breakfast was too much for us.

Attempts to relay the news to Windhoek by radio were frustrated by difficult transmission conditions. We eventually made contact with Windhoek by driving to the nearest farm and telephoning from there. This is not always very reliable since the telephone lines are highly susceptible to flood damage.

After tidying up at Etemba, we moved downstream, and caught up with the flood at a station called Nei-Neis after a 2½ hour drive. The access to the station normally ends with a 3 km drive down a dry river bed. The wet-weather access as a "rare" alternative ends with a steep pitch down a boulder-strewn ravine for 1 km on foot. Our enthusiasm was starting to wane a little by then as we cursed the people responsible for locating the gauging station. In all fairness, they had opted for the only feasible site on that particular stretch of river.

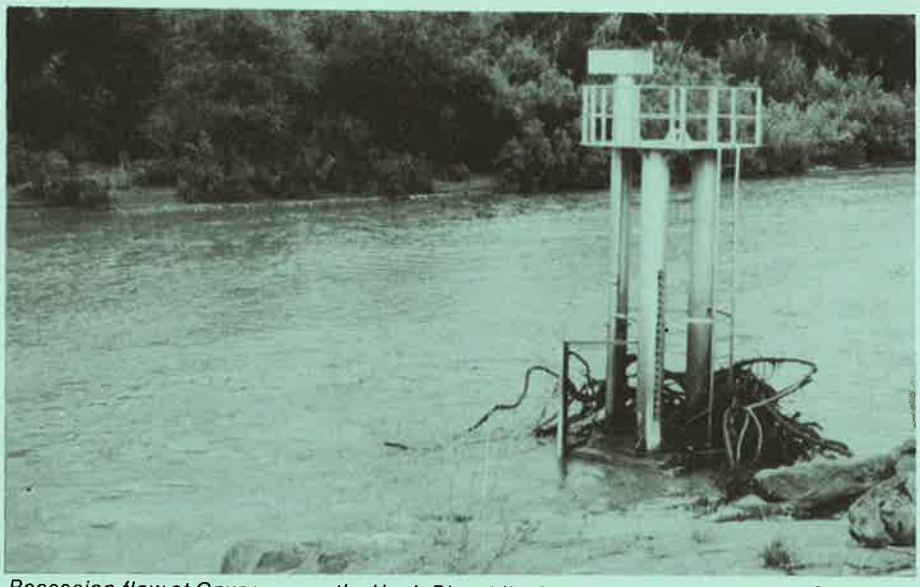
There was full width flow on our arrival at the station which meant that a wading-rod gauging was not possible. As a result we busied ourselves with a "stokkie" (float) gauging and attempted to repair the minor damage to the station caused by the floods. We decided that there would be little benefit from remaining any longer at Nei-Neis and consequently drove north about 75 km to a station called Onverwag

on the Ugab River. The drive to Onverwag was uneventful save for the last 2 km in which the vehicle became bogged down in mud just as it was getting dark. The 30 minutes it took to get the vehicle out was a sufficient reminder that the judgement of weary Hydrologists is far from perfect.

The following day (Wednesday) was quite restful in comparison to the previous two. A complete wading-rod gauging was possible at Onverwag followed by a slope-area survey. Slope area surveys have proved to be particularly important at stations where big flood events were either missed or alternatively resulted in flow conditions which did not permit the use of conventional methods of gauging. Problems have however been experienced with the identification of reliable flood marks.

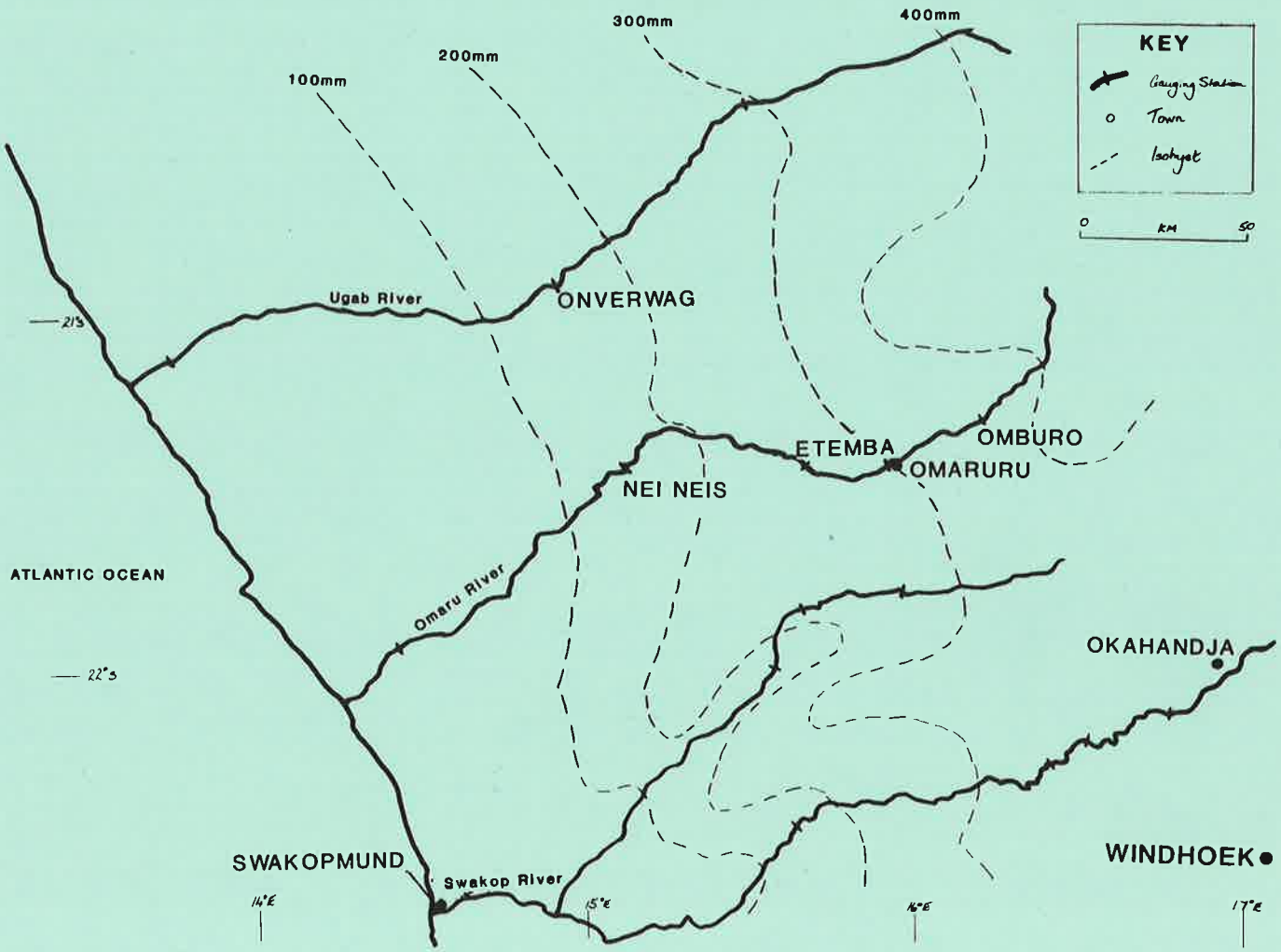
Further contact with Head Office indicated that there were no major floods on their way down either the Ugab or the Omaruru, but that we should stay in the area on the basis of promising forecasts issued by the Weather Bureau. Thursday was spent investigating the case of a farmer whose plot had been repeatedly inundated during the floods of the previous week.

The site visit involved a survey and some photographic work to provide moral support to the farmer until the matter could be attended to in detail. In the meantime sandbags would have to suffice. Following the checking of a nearby gauging station on the Omaruru River called Omburo, the sight of a wall of dark clouds to the east and the almost continuous rumble of thunder was clearly a prelude to some considerable rainfall. In addition, to the west, cumulonimbus clouds were rapidly pushing up to over 30,000 feet. Something big had to happen.



Recession flow at Onverwag on the Ugab River (discharge of approximately 9 m^3/s). Note the flood debris at the base of the tower.

Our immediate reaction was to drive to the town of Omaruru and grab a beer and some sandwiches for this was going to be a long night. As we left the town at around 1700 h, the rain began with massive drops that almost drowned the thunder as they hit the tin rooves. We returned to Etemba to await development, crossing a number of smaller rivers that were already in flood. On arrival at Etemba, the river was flowing, but only at a level of 0.25 m, i.e. recession flow from the previous flood. Just as the last mouthful of supper was being enjoyed, so the level began to rise. The team, whose operation was now highly polished rattled off a couple of cableway gaugings as the level rose to 2 metres. Above that level, the river was clearly not happy with the 50 kg torpedo and repeatedly spat it out with such ferocity that the entire cableway structure seemed to be at risk. Discretion being the better part of valour, we winched the equipment high out of the water and left it. Our attention then focussed on making comparative GP and



pen position readings as well as water sampling for silt analysis using the highly sophisticated "stick a 1 l sample bottle in a turbulent part of the flow until it's full" method. In between we just sat and watched as the level rose — not as a wall of water as our textbooks had said, but as a series of surges, each one building upon the previous one.

In so far as GP readings could be made, by 2300 h, the level had reached 2.5 m and an hour later was 3.0 m. Eventually at around 0100 h, a peak of 3.5 m was reached. This is equivalent to a discharge of approximately 520 m^3/s which has a return period of approximately 15 years. The inadequacy of the existing gauge plates was revealed since they only went up to 3 m. Gratifyingly, the sandbank that caused such problems at low levels, had little or no influence on the flow profile at high levels. To all intents and purposes the water surface was horizontal across the section with the hydraulic jump displaced well downstream of the weir.

It was an amazing experience to watch the water level rise. On the rising limb one simply has no idea just how high that level is going to climb. I was able to appreciate how frightening it must be for people whose life and possessions are at risk from rising floodwater. Scenarios of complete inundation may form in even the most unimaginative of minds whilst floodwaters continue to rise.

Having satisfied ourselves that the flood was eventually receding, we retired to bed, but sleep did not come easily. This was partly as a result of the mayhem going on in the river about 10 m from the cableway hut in which we were sleeping, but also because of what we had witnessed. Others who had observed the rising limb of large floods also commented that it put them in a mild state of shock. All of the power, concentrated into one mighty floodwave made one feel so small and insignificant. We all talk glibly in our offices of floods of so many hundreds of m^3/s, and return periods of so many years, but until you actually witness such an event, these concepts and terms must remain as abstractions of reality.

From a personal viewpoint, the observations that I made were an important part of my hydrological education. My advice to other practising Hydrologists, whether on official duty or not, is to get out there in the field and observe, for only good can come from it.

P. Webster
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ARCHIVING SHORT PERIOD RAINFALL

In response to comments made at a recent BHS meeting on the Meteorological Office's apparent lack of interest in data from recording raingauges, *Frank Singleton*, Assistant Director for Advisory Services, here summarises the Met. Office's policy for archiving short period rainfall, a policy which is being actively reviewed with appropriate approaches to water authorities.

As the National Weather Service the Meteorological Office has the responsibility of creating and maintaining the National Archive of weather information and, having acquired the British Rainfall Organisation by deed of transfer in 1919, this is particularly the case with regard to rainfall data. The Office commits a substantial proportion of its resources to the making, collecting and archiving of observations in general. For day-to-day weather forecasting and similar data applications all the effort is Meteorological Office funded while, for the climatological and rainfall networks, much of the observational effort comes from voluntary or co-operating observers but, even here, there is significant cost to the Office in setting up and inspecting stations, quality controlling and archiving data. A Meteorological Office Working Group is charged with determining policy for all observational networks. For synoptic and general climatological purposes the considerations about network design criteria are primarily of an in-house nature. For rainfall, however, cognisance is taken of other user requirements and, for that purpose, the report of the Joint National Water Council/Meteorological Office Working Group on the National Rainfall Archive is of fundamental importance.

The Joint Working Group recommended that, for England and Wales, the number of stations with daily data archived on computer should be in the range 2,000-2,800. These numbers represent network densities roughly equivalent to those suggested by O'Connell *et al* (1979) for the Wessex Water Authority area and by Nicholass *et al* (1982) for the Northwest Water Authority area. For recording gauges the Group suggested a total of 140 corresponding, roughly, to the World Meteorological Organization recommendation that the percentage of the network to be recording gauges should be at least 10 per cent in warm climates and 5 per cent in cold climates. A constraint having a bearing upon the amount of recorder data archived was the work involved in tabulating and keying data from Dines Tilting Syphon Recorders (TSR).

In recent years the introduction of the Tipping Bucket Raingauge (TBR) with event loggers creating data directly in a computer compatible form has opened up the prospect of much more rainfall recorder data being stored although the increasing unreliability of Magnetic Tape Event Recorders (MTER) caused the Meteorological Office to delay the introduction of any extensive archiving of TBR data. The development of cheap, reliable solid-state loggers, their introduction by Water Authorities and, now, by the Meteorological Office has resulted in a climate conducive to a fairly radical reappraisal of what ought to be and can be archived. A not unrelated issue is the de-manning of many Water Authority operations with the consequent introduction of reliable logging and telemetering systems.

Guidance on the density of daily rainfall gauges can be obtained by using techniques such as those described by O'Connell *et al*. There are also user requirements defined, rather subjectively, by those working in enquiry bureaux, analysing rainfall patterns or concerned with water supply and management. Summaries of needs are listed by O'Connell *et al* and Nicholass *et al*. Recent Meteorological Office work suggests that an intergauge spacing of daily gauges of around 6-8 km is needed to give accuracies at ungauged points of 20 per cent on 95 per cent of occasions of uniform (typically frontal) rain and on 40 per cent of occasions in non-uniform (typically showery) rain. The same spacing gives accuracies of areal rainfall over 1,600 sq km areas of 20 per cent on 99 per cent of occasions for uniform rainfall and on 68 per cent of occasions for non-uniform rainfall. An 8 km spacing of gauges equates to about 2,400 gauges in England and Wales.

For sub-daily, typically hourly falls, it is far more difficult to arrive at soundly-based design criteria for networks. O'Connell *et al* used data from some particularly dense but small experimental raingauge networks and suggested that gauge spacings of 20 km could give root mean square errors for hourly totals of around 2 mm when the actual rainfall exceeded 1 mm. More recent Meteorological Office work, still needing confirmation, suggests that even on occasions of fairly uniform rainfall a gauge spacing of 2 or 3 km would be required in order to estimate falls at ungauged points to within 20 per cent. It follows that any operationally feasible recorder gauge network can only give low accuracies for estimates of short period rainfalls.

O'Connell *et al* suggested the alternative approach of determining a recorder network density in terms of the probability of sampling a storm of moderate size, say of diameter 10 km. Taking a worst case of a stationary storm with a square lattice of spacing 20 km the probability of detection is about 80 per cent. Bearing in mind that a rain cell within such a storm will probably be of some smaller size, say half the area or 7 km diameter, then the probability of detection decreases to about 40 per cent. On the above basis, and to achieve such levels of detection, would require about 375 recorder gauges for England and Wales or about 600 for the

whole of the United Kingdom.

If such figures are accepted then can the Meteorological Office undertake the archiving into a computerised data bank? In terms of handling and processing records from the Dines Tilting Syphon Recorders the answer would be certainly not. In terms of handling cassettes from MTERs or cachettes from solid state loggers then the answer, again, would be probably not in the current Civil Service climate of reducing staff ceilings. If most of the data were supplied by Water Authorities and River Boards already transcribed to half inch, 9 track magnetic tape, then the answer is probably yes. If the data were to be on a floppy disk readable by an IBM PC then the answer might be yes. It is to this end that the Meteorological Office is writing to Authorities and Boards to enquire how much gauge data could be made available on magnetic tape at present and in the foreseeable future or in what alternative ways.

For ease of handling, and to have credence as a national archive, data should be continuous, or virtually so. Tips of buckets should be at increments not greater than 0.5 mm. Tips of 0.2 mm should be from 300 mm gauges and not from the smaller 8 inch (200 mm) gauge (the smaller mass of water does not seem to be sufficient to result in the bucket tipping in a consistent fashion).

There are a number of known problems with TBRs — e.g. they can give spurious tips in very heavy rain due to bouncing of the bucket or in strong winds due to vibration. Their behaviour over periods of extended and unattended operation is as yet unknown. In particular, they do not provide data during snow. Used as a recording gauge this latter problem is no more serious than for the Dines TSRs in that there is, simply, no usable record in snow situations. However, used in place of manned daily gauges then the data loss can be serious both from the aspect of a long term archive and for operational use in calculating the rainfall equivalent of lying snow.

The Meteorological Office recommends, where extensive de-manning results in TBRs becoming the main source of daily rainfall totals, that a skeleton network of conventional daily read gauges should be maintained. Where TBRs are used primarily to provide short period rainfall data then daily read check gauges on site are strongly recommended although weekly read totals would probably suffice. Where there is no check gauge then daily totals from TBRs will be checked against the background of daily gauge totals used for daily quality control of the data. This, however, would only indicate random errors of 20 per cent or, probably, more for individual storms. Errors of 15-20 per cent would become apparent over periods of months and differences of 8-10 per cent would probably show up from annual data.

The Meteorological Office Working Group on Networks has also been considering the effect of radar on the rainfall network. Current opinion is that, for archival purposes, radar data will add little to the current very good United Kingdom daily gauge network of 5,000 gauges. For daily totals, significant reductions in the gauge network would lead to a degradation in overall quality not likely to be compensated for completely by the addition of radar data. For sub-daily data the effect of radar is to be investigated over the next few years. Routinely archived radar data will be based on values at 5 minute intervals over areas of 5 × 5 km and it might be possible to use this information to apportion daily gauge data, or daily areal rainfall data obtained jointly from gauges and radar, to shorter periods. Whether such a technique is capable of providing better and more accurate results of estimated rainfall for short periods than can be derived from a recorder gauge network has yet to be seen. The above refers, of course, to the use of radar data to create an archive and in no way questions the use of radar as an operational tool. Indeed, work on the problems of trying to estimate short period falls using a typical network of recorder gauge data suggests that radar may be the only really feasible technique for the real time operational assessment of areal rainfall totals.

Frank Singleton

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British Association of Remote Sensing Companies

Many areas of the world are now being surveyed in detail for the first time, thanks to remote sensing. With the development of new airborne remote sensing systems and the launch of a number of new earth resources satellites over the next decade, British companies involved in remote sensing are optimistic that the range of practical applications of the images will grow rapidly. It is against this exciting background of development and commercial opportunity that a British Association of Remote Sensing Companies has been formed.

The United Kingdom is one of the leading nations in the development of remote sensing technology and the provision of international consultancy services based on its application. Association Chairman, Mr. Brian Tandy has stated that there is a particular need for a representative body in the private sector to establish a focal point for the remote sensing business in the UK and to provide a forum for representatives to make contact with government bodies and international agencies.

List of BARSC company members:
Hunting Geology and Geophysics Ltd.
General Technology Systems Ltd.
Logica Space and Defence Systems Ltd.
GEMS of Cambridge Ltd.
Geosurvey International Ltd.
ERSAC Ltd.
Scott Wilson Kirkpatrick and Partners.
Hays Space Technology.
GEC Research Ltd.
Clyde Surveys Ltd.
Spectrascan Ltd.
Geomorphological Services Ltd.
Oceanfix International Ltd.
Nigel Press Associates Ltd.
Smith Associates Ltd.
British Aerospace PLC.

The objects for which the Association is established are:

a) to conserve, promote and protect the interests of, and encourage co-operation between, all UK companies and partnerships offering and undertaking consulting and contracting services in the field of remote sensing.
b) To ensure that the interests of the Members of the Association are fully represented in all national, international and Government committees which may exist and exert influence on the spheres of interest and Members.
c) To liaise with Government Departments, Academic Institutions and other similar bodies when undertaking contractual remote sensing activities in the operation of the professional and commercial services provided by members.
d) To encourage International funding and executing Agencies or organisations instigating remote sensing projects overseas to co-operate with BARSC and its members.
e) To maintain the status of the Members and uphold professional standards by the establishment and development of a Code of ethics and conduct.
f) To provide a forum for representations to government and other appropriate bodies in connection with overseas trade visits and exhibitions.
g) To do all such other things as may be conducive to the attainment of the above objects.

BOOKS

Glaciers and runoff

Techniques for prediction of runoff from glacierised areas, edited by G.J. Young. International Association of Hydrological Sciences Publication No. 149, 1985. 149 pages, paperback, £18.00.

The hydrology of basins with even a small percentage cover of permanent snow and ice is distinctive. Much of the precipitation falls as snow during winter months, and runoff during summer is regulated by the accumulation and melting of seasonal snowcover and meltling of permanent glacier ice. Glaciers exert an important influence on discharge over a range of timescales such that, on an annual basis, runoff can exceed precipitation, in warm dry summers flow will be considerably higher than in summers with high levels of precipitation, there is a marked diurnal variation in flow pattern, and, over periods of decades, advances and retreats of glaciers lead to longer term fluctuations of runoff. Although heavy glacier cover is restricted to the more remote high mountainous areas, and to the polar regions, the impact of glaciers in hydrology is extensive. Flows in the headwaters of many great continental rivers originate from glaciers, in the western cordillera of North America, the Andes, the European Alps and Scandinavia. Meltwater sources are extensively used by irrigation and hydroelectric power developments locally in mountainous countries, and are particularly important regionally for example in central Asia where in summer water from sources other than melting glaciers is scarce. Techniques for prediction of runoff from glacierised areas of necessity differ from those known to hydrologists in liquid-precipitation dominated zones. Essentially, thermal conditions, although acting in differing ways and with differing timing on snow and ice substrates, determine melting and runoff, and liquid precipitation also leads to short term runoff variations.

This complexity has provided glaciologists and hydrologists with a challenging field, which has significantly opened up since the late 1960s. An appendix to this collection of articles on current knowledge and practices documents the growing and developing international interest in the hydrology of glaciers and of glacierised areas, and the volume itself results from the tasks a Working Group on Prediction of Runoff from Glacierised Areas convened by the editor under the auspices of the International Commission on Snow and Ice.

Prediction of runoff from glacierised areas is undertaken initially for planning, usually with few data available, and subsequently with improved observations for operational purposes. Methods are all too often basin specific, or peculiar to a particular climatic region. The volume is divided into overview and case study sections. After a general introduction, seven models in use are described and a limited comparison attempted in the overview, but it is the case studies which are most valuable. Case studies for hydroelectric development are presented for Switzerland, Canada, and Greenland, and for irrigation and flood control for China, USSR, and Pakistan, illustrating the range of problems, and the diversity of approaches.

The highest magnitude events occurring on glacier-fed streams are associated with the catastrophic draining of ice-dammed lakes, and prediction of the sizes, leaving aside timing, of the resulting floods is notoriously difficult. A range of empirical techniques is described in case studies from Nepal, Soviet Union, Pakistan and Canada dealing with individual floods and individual flood sites. Improvement of monitoring and the need to develop forecasting of these destructive floods is likely to be a major theme in glacier hydrology in the future.

Inevitably, individual contributions vary considerably in style, complexity and in the level of explanation. However, together they form a guide to current practice in predicting glacier runoff, and usefully flag for attention, as in the case of the USSR, models and methods which have not previously been widely distributed internationally. Although throughout, individual cases are described, with little attempt at inter-comparison, or classification of models by purpose or appropriate timescale, this is an important volume. It marks a significant series of advances, and provides the setting for continuing activity in the field of high mountain and high latitude hydrology.

David N. Collins

Hydrometry

Streamflow measurement, by R.W. Herschy. Elsevier Applied Science Publishers, 1985. 553 pages, hardback, £65.00.

To state that so much work in hydrology and water resources is heavily dependent upon the quantity and quality of flow records is something of a truism. Nevertheless, basic data collection is regarded by many as somewhat mundane, an attitude which is not assuaged by the formal prose of British and International Standards on the subject. Technical papers on hydrometry proliferate. In 1961, Kurtika published the details of over 3,000 references in 17 languages, an achievement nobody appears to have been prepared to emulate. The same reluctance has been evident in the preparation of textbooks, which have been few and far between. This book by Reg Herschy is therefore all the more welcome, bringing together as it does the details of the well-tried methods — velocity-area techniques, dilution gauging and measuring structures — and descriptions of the "exotic" approaches — ultrasonic and electromagnetic methods — as well as much useful information on stage-discharge relationships and data processing.

On page 1, the author tells us that the book is for field hydrologists and for students studying hydrology in universities and colleges. The book is indeed admirable for this readership, although more in the role of a compendium to be consulted according to need than a work that is read consecutively from chapters one to fifteen. The severe dent that the price will make in a student book allowance will unfortunately prove a deterrent to that sector of the potential audience, but "Streamflow Measurement" deserves and will earn its place on the shelves of professional libraries wherever hydrology is conscientiously practised.

M.J. Hall

Sedimentation

Methods of computing sedimentation in lakes and reservoirs, by Stevan Bruk. Unesco, 1985. Free from Division of Water Sciences, UNESCO, 7 Place de Fontenoy, 75700, Paris.

Despite the rather restrictive title, this 210-page report is probably the most comprehensive single document on the general topic of reservoir sedimentation since Brown's USDA publication in 1944. It has been prepared under the Unesco International Hydrological Programme by an international committee of eminent experts from USA, Europe and China.

The subject is set in context in the opening chapter by a general discussion of sedimentation in terms of its technical, economic and environmental aspects.

The physical processes within the reservoir are discussed in geomorphological terms in the second chapter which includes a description of wind, wave and solar effects and shoreline processes although these are normally considered as only secondary processes in engineering terms.

Field measurement procedures are outlined briefly in the third chapter, indicating how the well-established procedures are being improved by modern hydrographic equipment. This chapter is characterised by good cross references to manuals detailing the survey procedures. In addition a very useful section on radioisotopes is included as an appendix to the report.

The heart of the book is an excellent fourth chapter describing methods of preserving reservoir capacity. Over 50 reservoirs worldwide are used to illustrate 12 different methods. Many of these case histories were previously unpublished or only available in reference in Russian or Chinese, or in internal reports. The advantages and disadvantages for each method are described together with an indication of the success of each.

The next chapter briefly describes a range of predictive techniques from trap efficiency curves to numerical modelling, including a detailed section on density currents. Although this chapter does not review the techniques evolved in the last five years it does give a good description of the principles on which recent developments have been based.

The conclusion and recommendation section summarises the chapters and states that despite the initial terms of reference of the project "this report is not a guide with detailed practical instructions on how to deal with various aspects of reservoir sedimentation". However, it is recommended that such a guide should be prepared as part of the next phase of the Unesco International Hydrological Programme. I look forward to the publication of such a guide, if it is feasible. In the

meantime this report provides excellent background data for anyone involved in reservoir sedimentation studies and it is pleasantly surprising to find that it is distributed free of charge by Unesco.

Graham Thompson

Hydraulics

Developments in Hydraulic Engineering — 3, edited by P. Novak. Elsevier Applied Science Publishers, London and New York, 1985. 318 pages, harback, £40.00.

This volume is the third in the Elsevier series in Developments in Hydraulic Engineering. The book, which follows the same pattern as the two previous volumes in the series, contains chapters by a number of authors on various aspects of open channel and coastal hydraulics. The chapters cover a wide variety of topics, namely dispersion in rivers and coastal waters, sea outfalls, flood routing, ice and river engineering, inland waterways and ports and harbours. It is the stated intention of the series to provide authors with an outlet for presenting authoritative and up-to-date reviews of the state-of-the-art in areas of particular interest to them. This book achieves this aim but it is unlikely that any single reader will be interested in more than two or three chapters.

The two chapters on dispersion in rivers and coastal waters are well written and certainly represent the state-of-the-art in a field which has seen rapid advances during the last ten years. The chapter on sea outfalls is largely descriptive. It would have been much improved if the very brief section on numerical modelling had been extended. The chapter on flood routing describes in a clear and concise manner a method of flood routing based on the kinematic wave theory. This chapter is written in such a way that it should prove useful to both students and practising hydrologists alike.

The chaper on ice and river engineering is concerned with the effects of ice formation on discharges together with the determination of the forces created by ice on banks and hydraulic structures. The chapter is well researched and written. It will be of value to engineers in countries where heavy ice formation is a problem. The chapter on inland waterways seems to be the odd one out in this book since it is much more concerned with waterway management and types of barge than with canal hydraulics.

The final chapter provides an outline of the hydraulic problems associated with the design of ports and harbours. It does not present detailed design methodology but provides the reader with an overview of what has to be considered during the design process. There is no mathematical analysis of waves and tides. The chapter is very readable but only provides an introduction to the subject. The reader will have to go to the list of references for more detailed information.

The overall view of the book is that it is well written and carefully edited but that the wide variety of subject matter will mean that libraries are the only likely buyers.

Ian Goodwill

Rural Water supplies

Drinking-water quality control in small-community supplies. Vol. 3 of Guidelines for drinking-water quality, World Health Organisation, Geneva, 1985. 121 pages, paperback, Sw. fr. 17-. Available through HMSO.

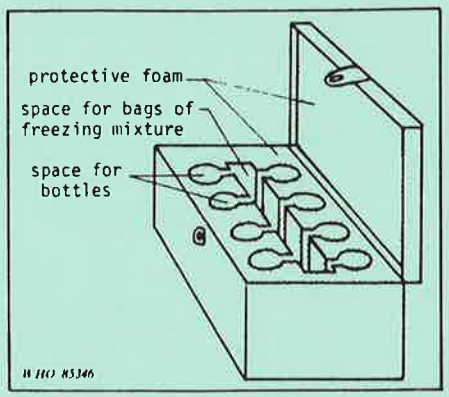
This completes the three-volume replacement for the 1971 edition of *International standards for drinking-water.* Volume 1 sets the new standards, volume 2 explains what the standards are based on; volume 1 was reviewed in *Circulation* in May 1985. The current volume explains how to measure water quality, particularly concentrating on microbiological aspects.

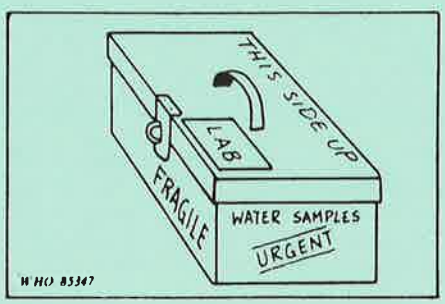
Sensibly, the book is *not* designed for use in Europe. It is a simple, well-illustrated manual for the underdeveloped world, and especially for surveillance of rural water supplies. For its purpose it is excellent, and should form the basis of the manuals consultants (and water authorities) leave as their legacy on rural water supply projects in India, Africa and the Far East.

A sample illustration is given below.

David Lerner

Fig. 6. Protective box for sample transport





A Book from IH

Multiple Regression in Hydrology, by R.L. Holder. Institute of Hydrology, 1986. 147 pages, £9.75. Order from IH.

In days of yore — or at least before the advent of pocket calculators capable of simple linear regression — the average sixth form student armed with a pencil and ruler and faced with an elliptical-shaped cloud of points on bi-axial graph, would probably draw a line along the major axis of the ellipse. What is more, had the axes of the graph been arbitrarily rotated, the line would have stayed where it was. Imagine his surprise then, had he been given one of these new pocket calculators, when he regressed either of the two variables on the other and discovered neither of the two regression lines it could produce coincided with his "by-eye" line through the major axis of the ellipse.

Lest the hydrologist should forsake the obvious and rely on unseen computation, R.L. Holder counsels well: his monograph contains an array of techniques for the "regression problem" but with the solid advice to the analyst never to abandon the simple graph, pencil and ruler.

R.L. Holder has tackled a difficult task well: describing the statistical procedures and detail of multiple regression (with all its variants encountered in reality) in a sound way to an audience of practitioners rather than statisticians is no easy task. Critjcism of the monograph is balanced by its obvious achievements. Indeed, some of the criticism derives from them: by giving the statistical techniques to enable some of the variants of straightforward multiple regression (if there is such a thing) to be considered — for example, the comparison of coefficients from different models, data transformation, replicate data for given determinands, etc. — the hydrologist has been provided with much greater scope with which to hang himself (and perhaps drown hundreds of others!). To counterbalance this perhaps a little more attention could have been paid to some of the fundamentals. For example, to return to the sixth form student, it might have helped to explain in more detail why regressing y on x is not the same as regressing x on y and why neither are the same as determining the relationship between x and y. For some readers, the quotation of statistical significance tests, etc. (rather than their origin and development) will be a source of relief, for others it might be a source of frustration. In a similar vein, the monograph passes very quickly from least squares regression to statistical regression — after all, the regression equations are the same, just the assumptions and connotations which are different — when perhaps more of a distinction could have been made.

Of course, all these criticisms are relatively minor, and, in any event, their incorporation would perhaps have turned a compact monograph and compendium of techniques into an unwieldly tome. The final chapter details some practical application of techniques. Interestingly, an example is included which represents a mini-version of the Flood Studies regression equation relating the mean annual flood to catchment characteristics. Two points emerge: that the regression model predicts the geometric mean annual flood rather than the arithmetic mean and that the assumption of common variance of the logged flows between catchments appears to be invalid. I hope some chickens are not coming home to roost! It is only an example after all.

In conclusion, "Multiple Regression in Hydrology" is a timely and noble contribution, which will serve hydrologists well.

P.W. Jowitt

Rainfall Data from the Meteorological Office

The Meteorological Office at Bracknell is responsible for the collection, quality control and archiving of rainfall data for the UK. The data are mainly observations of daily, monthly and annual rainfall totals from about 5,000 gauges. Summaries of these data are published in an annual series of paper-back books entitled "Monthly and annual totals of rainfall for the UK" the 15th publication in this series, that for 1983, now being available. The 1984 rainfall publication will be available in 2-3 months time while work on the 1985 volume is in hand.

Each publication is prefaced by an explanatory section, A4-size maps for the UK showing annual totals expressed in mm and as a percentage of the 1941-70 average and statistics of the monthly totals for England, Wales, England and Wales combined, Scotland, Great Britain, Northern Ireland and the Isle of Man. The main body of the publication contains tabulations of monthly and annual gauge totals (and highest daily total), together with the grid reference and altitude. The annual average (1941-70) is given when available. The publication groups gauges within river and tributary catchments.

Copies of the 1983 publication and back copies, are obtainable (price £6 which includes p and p) from:

Advisory Services Branch,
Room 232,
Meteorological Office,
Bracknell,
Berks
RG12 2SZ

Hydrological Applications of Weather Radar

Following the Lancaster Symposium last September, moves were made to bring together a group to promote research on the hydrological applications of weather radar. This group had its first meeting on 18 March where representatives of DoE, MAFF, the Met. Office, IH and several water authorities and universities discussed their roles in this field and decided on a programme of work. This will include identification of areas of research such as radar calibration and design of rainfall networks, real-time forecasting and urban storm drainage.

The Secretary of the Committee is Jon Finch at IH.

SITUATIONS VACANT

INSTITUTE OF HYDROLOGY, WALLINGFORD

1. An innovative, numerate hydrologist is required to join a group providing a water resources and flood estimation studies advisory service, mainly to British consultants. Initially the successfully candidate will give support to our present staff on a wide range of applied hydrological studies. When experienced, he or she will be expected to work alone, often overseas (sometimes for extended periods) and to be responsible for the bulk of the analytical work and for reporting on individual projects. Because available overseas data are often sparse, we are seeking a thoughtful, intelligent scientist or engineer to solve challenging problems. Mathematical and statistical skills are essential. The work will involve significant computing input using FORTRAN.

2. A second post is available at IH to work with a team undertaking the data analysis and modelling stream acidification. The duties will involve using statistical and time series packages to analyse data, writing modelling software and the interpretation of model results. A background in hydrology and chemistry would be useful and computing experience is essential.

Candidates should have a first or upper second class degree in engineering or science. An appropriate postgraduate qualification would be an advantage. The appointment, which will initially be for three years, will be at Scientific Officer (£6,190—£8,561) or Higher Scientific Officer (£7,788—£10,541) level depending upon qualifications and experience (salaries are currently under review). Staff of the NERC are not Civil Servants but their pay and conditions are similar to those of the Civil Service.

Application forms may be obtained from the Personnel Officer, Institute of Hydrology, Maclean Building, Wallingford, Oxon OX10 8BB (Tel: 0491 38800). The closing date for receipt of completed applications for post (1) is 23rd May 1986, and for post (2) is 6th June 1986.

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MONEY WORRIES

We are a little concerned at the Society's expenses getting out of hand in relation to meetings.

For example, we have received a bill from the ICE for £77.30 to cover the coffee, tea and biscuits consumed at the National Meeting held there on 17 February. Only 26 people paid in advance for their refreshments and the attendance book shows that 46 people were in the audience although a head count by one of the committee present suggests that there were more than that number there!

Seen in Unesco Recently . . .

Two Russians staring intently at a show case in one of the corridors featuring books and geological specimens. Their gaze appeared to be transfixed by a lump of rock labelled "Star Wars Agate".

FORTHCOMING EVENTS

Meetings

5th INTERNATIONAL SYMPOSIUM ON STOCHASTIC HYDRAULICS BIRMINGHAM — 2-4 August 1988

The international Symposium on stochastic hydraulic convenes every four years in different countries under the auspices of the International Association of Hydraulic Research. The fifth symposium will include as primary areas, risk and reliability in analysis and design of hydraulic structures and systems, stochastic approaches to hydraulic based flow forecasting and probabilistic methods in hydraulics.

Contact: Dr. I.D. Cluckie, Department of Civil Engineering, University of Birmingham, PO Box 363, Birmingham B15 2TT. Telephone 021-472 1301.

BHS AGM 9 December 1986

We propose to arrange a meeting on "Microcomputers in Hydrology" to follow this year's AGM. There will be an exhibition/demonstration of equipment running alongside and anyone with micros or software packages for micros who would be interested in showing their wares should contact David Boorman at the Institute of Hydrology soon, so that he can gauge the level of response — and hence space required — in good time.

NORDIC HYDROLOGICAL CONFERENCE Theme: HYDROLOGY & WATER HARNESSING UNIVERSITY OF ICELAND REYKJAVIK 11-13 August 1986

Sessions on: Collection and processing of hydrological data; Climatic factors as input to hydrological models; Runoff models; Operational hydropower hydrology; Hydrological soil parameters, analysis of groundwater level and evaluation of hydraulic parameters in aquifers; Soil- and groundwater modelling; Thermal and quality aspects of groundwater; Mass transport in air and water.

Contact: K. Einarsson, Orkustofnun (National Energy Authority), Grensavegi 9, 108 Rykjavik, Iceland. Tel: 354-1-83600. Telex: 2339.

INTERNATIONAL CONFERENCE WATER QUALITY MODELLING IN THE INLAND NATURAL ENVIRONMENT BOURNEMOUTH 10-13 June 1986

Sessions on: Water quality management; Integrated water quality modelling; Transport of pollutants — unsaturated and saturated zones; Pollution processes in lakes and reservoirs; Pollution processes in estuaries; River modelling; Acidification of surface and groundwater; Urban drainage.

Contact: Conference Organiser, Water Quality Modelling, BHRA, The Fluid Engineering Centre, Cranfield, Bedford MK43 0AJ. Tel: 0234 750422. Telex: 825059 BHRA G.

Stop Press

BRITISH HYDROLOGICAL SOCIETY NATIONAL MEETING DESIGN & OPERATION OF WATER RESOURCES SYSTEMS UNIVERSITY OF LOUGHBOROUGH 14 May 1986

This meeting, which is being held jointly with the International Association for Hydraulic Research and with which the Water Engineering Group Management Board is formally associated will take as its major theme the determination of the conditions under which water resources systems should be designated to operate. The meeting will hear of new approaches being applied in both design and operation by the Regional Water Authorities, and will also be reminded of the potential role of operations research techniques in managing both the quantity and quality of water. Speakers will include A.O. Lambert, Dr P.D. Walsh, T.R. Wyatt and Dr B.A. Finney.

Copy Deadline for Issue No. 11 — 4th July 1986

Courses

THIRD SHORT COURSE ON GROUNDWATER FLOW & POLLUTION WITH EMPHASIS ON THE PRACTICAL APPLICATION OF MODELLING TECHNIQUES June 30—July 4, 1986

Given by Professor J. Bear (Technion, Israel) and Dr. J.D. Porter and Mr. R. MacKay (University of Newcastle upon Tyne, UK), the course will be aimed at civil engineers, environmental engineers and scientists, hydrologists, hydrogeologists and regional planners who are engaged in the development, management and quality control of groundwater systems.

Participants will receive a thorough grounding in the practical application of numerical modelling techniques to groundwater flow and pollution problems. A major proportion of the course will be devoted to workshop sessions where selected case studies will be used to emphasize the strengths and limitations of numerical models. A prepared suite of codes coupled with computer data based field information will assist model building for the participants. These workshop sessions will be integrated with a programme of lectures and tutorial sessions which will cover the formulation of mathematical models of flow and contaminant transport in groundwater systems.

An optional two-day course on the use of numerical techniques for solving the equations of flow and contaminant transport will be available on the 27th-28th June for those who are interested.

Further details from: Prof. P.E. O'Connell, Department of Civil Engineering, University of Newcastle upon Tyne, Newcastle upon Tyne, NE1 7RU. Tel: (0632) 328511 ext. 2405.

Diary

14 May
BHS National Meeting.
"Design and Operation of Water Resource Systems."
Loughborough University.

17-19 September 1986
Welsh Hydrological Group BHS/ Association of British Climatologists.
"Water: measurement and management".
Swansea University.

15-16 October
Scottish Hydrological Group/Royal Society of Edinburgh.
'Hydrology in Scotland'.
Edinburgh.

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. Telelphone: 0491 38800 extension 2224.