THE NEWSLETTER OF THE BRITISH HYDROLOGICAL SOCIETY

Circulation

No. 4

November 1984

ONE YEAR OLD!

Report by the Honorary Secretary for the year ending 30 September 1984

When an established Society begins a new year, its elected officers can look forward to administering a programme of activities that is at least confirmed in broad detail. A newly-inaugurated body is not in this fortunate position. Nevertheless, the British Hydrological Society can look back on its first 12 months with some sense of achievement. Five National Meetings were organised, and 2 Regional Sections of the Society were set up which each held 2 meetings. A full programme of events has been compiled for 1984-85, with 5 (and possibly 6) National Meetings and 6 Regional Meetings. Indeed, taken together with the activities of the Welsh, Pennines and Scottish Hydrological Groups of the Institution of Civil Engineers, no less than 22 meetings with a hydrological bias are being offered during the coming year. With the Society launching its newsletter, "Circulation", having a quarterly distribution, the promotion of hydrology in the United Kingdom has never been better served.

This level of activity has not been achieved without a considerable amount of effort on the part of the Main Committee. Six meetings of the latter were held during the past year, with three in London and one each in Wallingford, Swindon and Reading. On two occasions, all members have attended and only once has the number fallen below the 70 per cent mark. For the last three meetings, the Main Committee has been strengthened by the co-option of representatives from the Pennines and Scottish Hydrological Groups, and the last meeting was attended by the co-ordinators of the BHS Southern and Midlands Regional Sections, bringing the total membership (including the Secretary) to 16.

The agendas for the Main Committee meetings have been wide-ranging, but a large proportion of time has been devoted to the programme of National Meetings and the encouragement of regional activities. The policy of varying the venue of National Meetings in an attempt to ensure that the majority of members will have at least one opportunity to attend without incurring substantial travel costs has been actively pursued. As a result, only one of the five National Meetings was held in London, and during the coming year only two out of five are proposed for London venues. The Society is therefore indebted to those members who acted as local organisers for the meetings in Birmingham, Loughborough, Newcastle-upon-Tyne and Edinburgh, and who have thereby helped to establish the procedure and routine for organising such events. During the coming year, further new ground will be broken by the holding of National Meetings jointly with other Societies.

Reports on the National and Regional Meetings of the Society have provided a substantial amount of material for "Circulation", and here the efforts of the reporters must be gratefully acknowledged. The scope of the newsletter has expanded to include short articles as well as news from members and a diary of forthcoming events. With the establishment of a regular publication schedule, as announced in issue number 3, the Main Committee hope to increase its value as a means of communication between Society members. In addition, the Society was able to produce a Membership Directory in January, 1984. This publication is expected to be issued annually.

Other Main Committee activities of note include the final drafting of the Society Statutes, and the preparation and circulation of a questionnaire on professional status and qualifications. Approval of the Statutes will be considered at the forthcoming Annual General Meeting, and their content will not therefore be considered further in this Report. The questionnaire formed the first step in an investigation arising from work by the Society's Initial Planning Group which indicated that wider consultation should be undertaken on the topic of recognised qualifications for hydrologists. As reported in the third issue of "Circulation", almost one-third of the membership replied to the questionnaire. Their experiences and suggestions are expected to provide a firm basis upon which the Main Committee can decide upon what action, if any, will be required in the future. A more detailed analysis of

☆ BHS AGM – 10 Dec ☆

Society members may wish to make a particular note in their diaries of the first Annual General Meeting, which will take place on 10 December 1984, at the University of Birmingham. In addition to receiving reports from the Honorary Officers and the Editor, the major item on the agenda will be the approval of the Society Statutes, copies of which will be distributed with the formal notice of the meeting. The AGM will begin at 11.00h and is only open to Society members. At approximately 12.00h, a BHS National Meeting entitled "Hydrological Education and Training in the 1980s" is scheduled to start. Three sessions have been organised that will deal with "Education", "In-career Training" and "Opportunities" respectively, all of which are topics that the questionnaire circulated by the Society's Initial Planning Group identified as being of considerable interest to members. The Main Committee hope to see you there.

results is being undertaken and will be reported to the membership in due course.

Under the terms of the draft Society Statutes, the members of the inaugural Main Committee serve for a minimum period of two years. There are therefore no elections to be considered at the forthcoming Annual General Meeting. However, in the Autumn of 1985, the Society will be asked to elect both a new President and Honorary Treasurer and two Main Committee members. In the meantime, the Honorary Officers and Main Committee would welcome your views on the scope and level of activity now being provided by the Society.

M.J. Hall

TREASURER'S REPORT

As the end of the financial year (i.e. 30 September) has only just passed I obviously do not have to hand the exact state of our finances, but it is in the order of £900 in credit. As this is our first year, with all the attendant extra expenses, I think this is quite a healthy state of affairs.

With the current membership at about 440 (and still rising) the number of Regional Sections and Regional Sections Meetings are growing, so I can envisage some extra expenditure in this area this coming financial year.

Despite this I am sure we will not have to increase our subscription just yet. Hopefully I will be able to confirm this and the exact state of our finances at our AGM on 10 December.

Anne Roberts

BRITISH HYDROLOGICAL SOCIETY
Committee

President
M. Mansell-Moullin,
Old Hatch,
Lower Farm Road,
Effingham, Surrey, KT24 5JL.

Hon. Secretary
Dr M.J. Hall,
21, Pamela Gardens,
Eastcote, Pinner, Middlesex, HA5 2QU.

Hon. Treasurer
Mrs A.M. Roberts,
Institute of Hydrology,
Wallingford, Oxon, OX10 8BB.

Prof K.J. Gregory,
Department of Geography,
The University, Southampton, SO9 5NH.

Prof M.J. Hamlin,
Civil Engineering Department,
University of Birmingham,
Birmingham, B15 2TT.

W.L. Jack,
2, The Promenade,
Brecon, Powys.

Dr M.J. Lowing,
Whitehouse Lodge,
Brightwell Baldwin, Oxford, OX9 5NT.

Dr J.C. Rodda,
Institute of Hydrology,
Wallingford, Oxon, OX10 8BB.

Dr D.E. Walling,
Department of Geography,
University of Exeter,
Amory Building, Rennes Drive,
Exeter, Devon, EX4 4RJ.

Representing IH
Mrs C. Kirby,
Institute of Hydrology,
Wallingford, Oxon, OX10 8BB.

Representing ICE
Prof P. Novak,
5, Glendale Avenue,
Whickham, Newcastle-upon-Tyne, NE16 5JA.

R.J. Sargent (co-opted)
7, Baberton Mains Drive
Edinburgh EH14 3DF

Dr. P.D. Walsh (co-opted)
"Abbeystead"
12, Highgate Avenue
Fulwood
Preston PR2 4LL

Secretary to the Committee
N. Tyler
Institution of Civil Engineers
25, Eccleston Square
London, S.W.1.

Further details about the Society and membership forms are available from the Secretary.

New Flood Warning and Data Collection System for the Greater London area

With the completion of the Thames Barrier and the consequent protection against all but the most extreme of tidal surges travelling up the Thames from the North Sea, there remains a continuing threat of flooding, caused by heavy rainfall, on the 300 km of rivers within the 1,030 km² area for which the Greater London Council (GLC) has land drainage powers.

The GLC has operated a flood warning system for these non-tidal rivers for the past twelve years. Warnings are issued by the Council to London borough officers and other authorities. To improve the quality of these warnings the Council is nearing completion of a scheme which includes a data retrieval and processing system based on a mini-computer, a weather radar and microprocessors. Data retrieved in real-time from the radar and other data collection devices will be input to mathematical models to predict river levels at several points on London's rivers. Warnings will then be issued, based on forecasts made by these models.

The heart of the new system is a DIGITAL VAX-11/750 mini-computer. Peripherals attached to the computer include duo-tone and colour VDUs, line-printers, colour plotters and a micro-computer.

A weather radar provides the primary data source for the flood warning system. The radar, which is located 35 km to the north-west of London, has been installed by the London Weather Radar Project: a consortium made up of the Meteorological Office, GLC, Thames Water Authority and Southern Water Authority. Data are received from the radar every fifteen minutes, 24 hours a day, 365 days a year. Additional rainfall data are obtained from twenty 0.5 mm tipping bucket rain-gauges. These gauges will be used to evaluate the accuracy of the radar data. If it is found to be necessary, these gauges will enable the Council to perform its own real-time re-calibration of the radar data. River levels are measured at a further twenty sites throughout London using optical shaft encoders. These have replaced ageing punch tape recorders. The rain-gauges and river-level instruments are attached to Dynamic Logic Microlog telemetry equipment which permits on-site storage of data covering several days with a sampling interval of 15-minutes. The equipment facilitates the down-loading of data to the VAX over the Public Switched Telephone Network on demand from the Council's duty officers. In addition alarms can be raised by the equipment to alert the duty officer to conditions such as high river levels or rainfall exceeding a pre-defined intensity.

The radar, rain-gauge and river-level data, together with Meteorological Office soil moisture deficit data are stored on an on-line, menu-driven data-base which is maintained on the Council's IBM 3033/3081 computer installation.

Real-time rainfall-runoff modelling utilises a state-updating version of the Isolated Event model and a synthetic unit hydrograph model. These models use telemetered real-time radar and river-level data to make their forecasts.

To enable forecasts to be made of the location of properties at risk to flooding, the floor levels of 8,900 properties in the London area have been obtained. Then, given a forecast of river-level for a particular point, it is possible to determine which properties in the vicinity of that point are at risk of flooding.

W.S. Eyre

SNOWMELT

Report of the Joint BHS and Scottish Hydrological Group meeting at Edinburgh University, 24 September 1984

Is snowmelt research a solution looking for a problem? It must certainly have seemed so to the 50 or so members who attended the recent BHS Snowmelt conference at Edinburgh University. The conference format exposed the wide gulf separating research in this field from application in the real world of water authority cutbacks and understaffing. The morning session was devoted to the research side, dominated by the Institute of Hydrology and complete with complex maths and ingenious instrumentation. In the afternoon, expediency was brought a little closer with papers on attempts to measure and model snowmelt on a catchment basis but the meeting really came to earth with a survey of current practice in the water authorities which showed how few measurements are made, and how little interest there really was in snowmelt forecasting.

Dr. McCulloch, Director of the Institute of Hydrology (IH), opened the meeting with an historical review of snowmelt research at the Institute. Its first annual report had suggested research into snowmelt but had been met with very little enthusiasm from the then River Authorities in England and Wales. A research proposal at Aviemore had to be abandoned because of high instrumentation costs and the subject died for a number of years to be revived briefly for the Flood Studies Report in 1975 where its 25 pages contributed 2% of the Report. The bane of snowmelt research has always been the difficulties in measurement and modern technology is now making some inroads into this problem. In parallel with these developments was an effort to achieve a better understanding of the physical processes and these two advances were leading to better models.

Progress in snowmelt modelling at IH was described by **Liz Morris.** The modelling equations were based on those for soil but with the added complication of the matrix transforming into the leachate and vice versa. In classic style these complex equations are then simplified and calibrated with actual values found from experiment. The experimental data are very sparse, however, and do not perform well against the theoretical treatment. The rather crucial question of whether snowmelt processes should be modelled using equilibrium or rate of process equations had yet to be answered and modelling was still in its infancy, largely because of the dearth of data.

The other prong in the Institute's attack on the problem, better instrumentation, was described by **Richard Harding.** At Aviemore the amount of snow held and lost from trees has been measured by gamma ray attenuation and by tree weighing. The gamma rays were passed horizontally through 40 metres of forest and attenuated by water. Tree weighing is just that; a tree is cut through at its base and a load cell placed between the halves. The weight of the tree plus intercepted snow and rain can then be monitored constantly. These experiments had shown that much more water can be stored on a tree in the form of snow than as rain, and that evaporation of snow from trees can be unexpectedly high, up to 0.4 mm/hr. These two findings suggest that loss of water from forested areas in winter is much higher than anticipated.

Richard Harding also described experiments in Norway where instrumentation of a frozen lake allowed study of physical processes and snowpack roughness where turbulence was much reduced. Roughness had varied dramatically on a day-to-day basis, and was lowest after fresh snowfall. He had also found air temperature close to the snow surface to be kept constant by the snow, despite variations in upper air temperature.

The variations in roughness proved to be of great interest in the discussion since most of the heat input to a snowpack is from turbulent transfer rather than radiation. The possibilities of modelling the changes with time were discussed, and the scale of the roughness, from granular to drifts, was of interest but unfortunately had not been measured because the variation was unexpected.

The afternoon session started with two papers on modelling snowmelt on a catchment scale by **Dave Archer,** from Northumbrian Water Authority and **Rob Ferguson** of Stirling University. In the North East of England Dave Archer had found catchment rates of snowmelt much greater than the point rates estimated by the Meteorological Office; the degree days yield was fairly constant between catchments for a given event but could vary significantly between events. Rob Ferguson explained that in the Cairgorm Mountains of Scotland, diurnal snowmelt dominated the runoff in the spring and early summer each year; large runoffs, averaging 20 mm/day, were produced because the snowpack can last into late spring when higher air temperatures occurred. His simple model averaged snowmelt rates by assuming an equivalent melting altitude and updated the snow covered area according to the previous snowmelt. The model worked well, and best in years with most snow. The parameters of his fitted model seemed stable but the snowpack densities were much higher than those usually accepted. To check this, a snow survey in 1984 had found values of snow densities around 0.6–0.7 compared to the normally recommended 0.1. These results produced surprise and some discussion in the audience.

Geoff Reynolds, recently retired from the North of Scotland Hydroelectric Board, gave a contribution from his large experience of floods in the highlands of Scotland. Unlike most workers in the field he thought the max. rates of snowmelt published in the Flood Studies Report were too high and suggested a max. rate of about 35 mm/day for the highlands. He also thought Dave Archer's figures were suspect but they were defended by Dave who was sure they suggested rates of 90 mm/day. It was suggested that windspeed was an important factor in determining turbulent transfer and, in view of the data presented by Richard Harding, perhaps more important than temperature. "Should we stop measuring temperature?" was an unanswered question.

The conference was then reminded of the gulf between research and practice by **Mike Mansell-Moullin** who presented the results of a telephone survey of snowmelt modelling and forecasting in the water authorities. There were very few observations of snowdepth and even fewer of water equivalent; there was very little data on snowmelt contributions to floods, and therefore little enthusiasm to do more. A map of where observations on snow and water equivalent were made was almost the reverse of a map of where the most snow fell. Only about half of the authorities attempted to do any forecasting, for the most part manually. It was, of course, impossible to forecast snowmelt where no data were being collected.

This apparent lack of interest was reinforced in the discussion, though Yorkshire Water Authority for one appeared interested in applying snowmelt research to their operational problems. If operational hydrologists are not particularly bothered about snowmelt others soon will be, because high pollutant levels, particularly acidity, are associated with snowmelt events. Perhaps the next snowmelt conference will be organised by the Institute of Water Pollution Control or the Institute of Biology!

Bob Sargent



IH gamma ray attenuation rig in Queens Forest, Aviemore

Publication of Papers

The Institution of Civil Engineers have confirmed that they would welcome the submission of more papers on hydrological topics for consideration for publication in the Proceedings. The number of such papers appears to have declined in recent years and the Institution is therefore keen to encourage prospective authors. The Proceedings are seen worldwide by a very large number of the Institution's members and so are a good forum for appropriate papers. The Institution's notes on the preparation of papers for publication give important guidance and should be requested before writing a paper.

As part of the publication process, copies of all papers submitted are sent to referees for review. The Institution's Water Engineering Group Management Board (Chairman Mr. F.F. Poskitt) would be very pleased to hear from members of the BHS who are prepared to act as referees. It would be helpful if they would state their fields of special knowledge or experience when writing to the Board. All correspondence should be addressed to The Secretary, Institution of Civil Engineers, Great George Street, London SW1P 3AA.

NEWS FROM MEMBERS

We have not had much time for this issue to gather our usual snippets of news but a couple of interesting items have been sent in which help to keep us up to date on developments within the industry.

LEVELS OF SERVICE

Measurement for the level of service which Water Authorities provide to their customers is, very properly, in fashion. So far most such measurements have related to water supply, sewerage and sewage treatment, but recently levels of service measures are being developed by Anglian in two fields of direct interest to Hydrologists, namely Water Resources and Land Drainage.

The measure developed for Water Resources is the proportion of sub-catchments (or per cent of area) in which the availability and quality of raw waters measure up to stated criteria on a 1-5 scale. In assessing this, account is taken of all classes of customer (public supply, direct water users and in-river needs). A possible target level of service would be to make water available in all sub-catchments with only minor limitations or works by customers, and with only minor quality problems. Less than 20% of Anglian's area currently measures up to this standand. It would not however be economic to augment all sub-catchments and any formal target level of service is likely to recognise this by calling for augmentation only where it is economic to do so.

(Contact David Evans.)

The frequency with which land and property are flooded is of consequence to the public and a Water Authority has powers to provide proper standards of defences against fluvial and tidal flooding. A realistic criterion for the existing level of service is "the flood return period (FRP) against which protection is given". Such a measurement will indicate to the public the degree to which it is protected. It does not however indicate if the protection is at the proper level.

To determine the proper level, ideally each and every length of defence should be examined to determine whether or not it is economically worthwhile, (i.e. the resulting benefit is greater than the cost) to improve the standard of protection. The examination should be one in which the difference between the benefit and the cost has been maximised. Thus the corresponding flood return period becomes a target level of service substantiated by sound economics. The difference between this level of service and the existing level of service identifies a shortfall.

(Contact Andrew Hunter Blair.)

WATER ABSRACTION LICENSING LEGISLATION

The WAA's Commercial Group is to consider (along with other amending legislation) possible alterations to the law relating to water abstraction. This follows a seminar last summer which was attended by legal and technical staff of most Water Authorities.

Those at the seminar accepted the underlying principles of "first come, first served" and "no derogation", though the thought has been put that first come first served can hinder the optimum allocation of water, and that perhaps, in determining applications, Water Authorities could have regard to predicted demands.

Other aspects where changes are to be considered include:

- clarifying what is licensable and what is not e.g. domestic use, heat pumps, fish farming, other intensive farming, trickle irrigation etc.
- simplifying the licensing procedures including variation and succession procedures.
- possible extension of exemptions e.g. on the lines of the Northumbrian WA Act 1981 which allows Orders to be made to exempt up to stated amounts in stated categories or areas.
- possible provision of a register of non-licensable protected rights (so that Water Authorities can assess derogation risks without the services of a clairvoyant).
- possible changes for processing applications.
- clarification of duties under the Countryside and Wildlife Act.

CHy MEETING IN GENEVA

One of the specialised commissions of the World Meteorological Organization, the Commission for Hydrology, met in Geneva at the end of August. **John Rodda** and **Max Beran** (IH) with two representatives of the Meteorological Office made up the UK delegation. The Commission reviewed the progress of the Operational Hydrology Programme within WMO over the four years since it last met. It planned the direction the Programme would take over the next four years. Important to these discussions was the progress made with the Hydrological Operational Multipurpose Subprogramme (HOMS), the system for the transfer of technology from developed to less developed countries. The UK HOMS centre is at IH and through it UK hydrologists have made a number of important contributions to the transfer of hydrological technology particularly to countries in Africa. In the elections of rapporteurs to carry out the work of the Commission until the next meeting Max was re-elected to the post of rapporteur on the World Climate Programme.

MEMBERS ON THE MOVE

Apologies from the editor for describing **John Riden's** post incorrectly in our last issue; he is hydrogeologist in Welsh WA's Northern Division, at Mold. Other BHS members involved in the recent reorganisation are **Nigel Clement**, Technical Assistant in South Western Division at Haverfordwest, **Alun Hughes**, Area Hydrologist in the same Division but based at Swansea. In the Northern Division **Alan Weston** is Area Hydrologist at Mold and **Alan Williams** is Technician at Bangor. All these posts became effective on 1st September.

Appropriate Technology for Third World Water Needs

Appropriate Technology is a term used today to describe both a method and a movement. In its most literal sense it is the appropriate application of scientific knowledge to development. Appropriate Technology is also used to describe the movement which started 20 years ago and which is now active through AT Units, Institutes, Associations and other bodies all over the world.

History

The view that much of Western technology was inappropriate to developing countries has been expressed by a few thoughtful people such as the late M.G. Ionides, a British civil engineer with wide experience in the Middle East, for nearly 60 years, but most of this time the world in general was not willing to listen to what they had to say.

In 1965 Fritz Schumacher founded the Intermediate Technology Development Group (ITDG) in London for the purpose of developing programmes on technologies for rural life in developing countries. Michael Ionides, was an original member of the Water and Power Panel and was the group's senior water consultant until his death in 1978. In 1970 the Water and Power Panel divided into two separate panels. Other ITDG panels cover building, social development, and education and training.

In its early years the ITDG Water Panel was actively engaged in promoting low cost simple technology in water conservation and storage.

Water Needs of the Third World

In considering the water needs of the Third World we should be careful not to oversimplify the issues. Needs can be divided into those necessary to sustain life and additional needs required to enable people to live fully and effectively. Even where basic needs only have to be met under an emergency, this is a temporary solution and sooner or later water requirements have to be seen in the context of a development rather than an emergency situation.

The more common use of technology for meeting the water needs in the Third World is concerned with improving some existing facility. It may be a case of increasing the yield of a source, or bringing water nearer to dwelling places, or removing the health hazards of polluted water, or making better use of a source for watering animals, or for irrigating crops or for fishponds. Whatever the needs, thanks to science and technology, technical solutions can usually be found. In the 1950s and 1960s when money went further than it does today and when funds for aid and development were more plentiful, many of those involved in development believed that it would only be a matter of time before technology would be able to satisfy the water needs of all the people in the Third World. For hydraulic engineers the catchword was "control". It seemed that once river systems could be controlled and their resources harnessed, the problems of surface water sources would largely be solved. And so hydraulic research became absorbed with the design of control structures, controlled discharges, erosion control and books and papers were published on the control of water.

It would be wrong to suggest that the Third World has gained nothing from this type of hydraulic activity, but the gains have been small compared with the effort and resources expended. The pursuite of technology for its own sake is a neutral activity. Schumacher was very concerned about the domination of the world by technology, and asked, "Can we develop a technology which really helps us to solve our problems — a technology with a human face?" Technology applied in ignorance of its consequences in human terms is counterproductive. This can be illustrated by some examples.

It was believed 20 years ago that borehole supplies should be extended and developed throughout the Third World and thus many massive drilling programmes were started, sometimes with very little preliminary hydrogeological investigation.

Most of these programmes were undertaken jointly by an international or bilateral aid agency with a recipient Government Water Department or Authority. With little concept of the value of the investment made on their behalf, the people would begin to enjoy its benefits. All would go well for a few years. New machinery required little attention beyond routine maintenance and even when unmaintained and unlubricated, the machinery survived for a while. But sooner or later the equipment would begin to deteriorate and a few weeks or months after that there would be a major breakdown and the water point would cease to supply water.

A second example of the application of technology to water development without proper attention to human factors may be found in the construction of dams and storage reservoirs. Dam construction was part of the controlling water crusade of 20 or 30 years ago and small earth dams became a popular feature of the development programmes of many Third World countries. Now there is nothing wrong with storing water for a useful purpose, but the dam planners were inclined to be carried away by their enthusiasm.

During the 1960s the Water Development Department of Uganda constructed over 100 earth dam storages in the drier Northern parts of the country. Few of these have been put to any use other than serving as watering places for cattle during the dry seasons and by 1983 many of the dams and spillways were in a poor state of repair, and several had been destroyed.

A third example of the problems of technology in the Third World may be seen in the many water supply schemes for small urban and semi-urban communities which incorporate water treatment systems. It is a common experience in many developing countries to find a water treatment system intact in that raw water extracted from a river source follows a correct route through sedimentation tanks to sand filters and then into contact tanks for sterilisation. But because of the unavailability of chemicals and spare parts, of staff shortages and inadequate supervision, raw, untreated water passes on into the service reservoir and thence to the consumer. Here again, many of these installations were provided under aid programmes and donors and their technical advisers cannot avoid sharing some responsibility for the outcome of their interventions.

AT applications

One of the most widespread and directly accessible sources of water is rainfall itself. Although rainfall harvesting has been practised in some parts of the world for several thousand years little attention was given to this until the 1960s when these techniques were revived and adapted to modern use. Today, all over the developing world, micro-catchment systems are collecting rainfall from the roofs of buildings, paved land surfaces and natural ground to provide water for domestic use and agriculture.

In many upland areas water supplies are derived from springs. Although the water emerging from a spring is usually pure and unpolluted, the use of a spring source indiscriminately for collecting water, bathing, washing clothing and watering animals, pollutes the source and surrounding area. The protection of springs is often an important feature of low cost water improvement programmes.

The development of shallow groundwater also offers opportunities for Appropriate Technology in the construction of hand-dug wells, underground galleries and shallow tube wells, which can sometimes be driven by manual labour.

Many kinds of simple manpower operated water lifting devices have been used in different parts of the world for hundreds of years. In the case of swinging baskets, scoops and buckets there is little scope for technical innovation. In other cases such as the counterpoised lift (or shadouf, as it is known in the Middle East), rope and bucket systems, various kinds of chain lifting devices and different types of water wheel, Appropriate Technology has been applied to improve efficiencies in some cases, but on the whole these devices have remained much as they have always been. Most of the scientific interest in improving water lifting technology for the Third World has centred on the reciprocating hand pump.

Water lifting requires energy and the most readily available source of energy to human beings is human power. But it should be remembered that the human individual is not a large power unit when compared with the mechanical power sources available in the modern world today. For pumping water in the Third World, and bearing in mind that it is often women and children who do the work, human power is usually taken as 100 watts per person. The human body is capable of developing much more power in short bursts, but tests carried out in Africa have shown that 100 watts per person is about right.

Animal power is used traditionally for raising water in many developing countries throughout North Africa, the Middle East and Asia. Animals are used in two ways:

(i) For direct lifting by hauling a rope or rope ropes to raise a bucket, and

(ii) For operating a water wheel or chain of buckets (saqia) through gears by walking on a circular track harnessed to a pivoted arm.

The first method is usually employed in semi-arid pastoral areas for raising water for stock and domestic use. The second method is more appropriate to the prolonged continuous watering required for irrigation. As continuously working animals require about 40% more food than grazing animals, this extra food has to be taken into account. If all animal fodder is provided on irrigated land, one working animal would need about 0.8 ha of land for its food production.

Wind power is today a popular source of alternative energy and the direct use of the sun's energy for mechanical power has attracted the attention of scientists and engineers for over 100 years. The development of the photo-voltaic cell which converts sunlight directly into electrical energy has been a breakthrough in solar energy conversion. Although solar pumping systems consist of highly sophisticated technology, the equipment produced for practical use is robust. The systems require little operational attendance beyond keeping the equipment clean and the pumps free from sediment. On the other hand if there is an electrical failure it would be quite beyond the means of local resources in most developing countries to trace and cure a fault, and servicing and repairs could be very costly indeed.



Excavation for infiltration gallery for water supply, North-west Somalia



Spring protection work at Atekwa Gwodo, Soroti District, Uganda

Another form of natural energy which has been used for 2,000 years or more is the energy of falling water and during the past decade there has been a recovery of interest in small scale hydro power systems.

The storage of water is a topic which has attracted a lot of attention from promoters of AT and this has led to a number of interesting developments. The simplest form of small, localised storage is the rainfall catchment tank. This is not new and excavated tanks and cisterns have been in use in North Africa, the Middle East, Asia and elsewhere for hundreds of years.

In the 1960s C.W. Lauritzen of the US Department of Agriculture, Utah, was one of the most active workers in the USA on the research and development of plastics for waterproofing small reservoirs for rainfall catchment. At about the same time Ionides was evolving a technique using layers of thin poly-ethylene and clay for waterproofing excavated catchment tanks in Western Sudan.

For storage below ground the walls of the tank have only to be waterproofed because the ground itself supports the weight of the water. But above ground the walls have to be both waterproof and strong enough to hold the weight of the water they contain. There is a wide range of ready-made commercial tanks available, but usually these are too costly for small rural communities. Alternative AT solutions have included ferro-cement construction and cement plaster with basket-work reinforcement.

A very important application for AT concerns the treatment of water for domestic uses. Slow sand filtration, a system which was in common use all over the world before the development of the rapid sand filters of the modern waterworks, is a treatment which is appropriate for developing countries.

The future

Mr Abdel Mageed, a distinguished water engineer from the Sudan who, as Secretary-General of the 1977 UN World Water Conference, played a leading role in launching the International Drinking Water and Sanitation Decade, made a powerful plea in his contribution to the discussions at the Second African Water Technology Conference in Nairobi in April 1984, for a better understanding of Third World aspirations. He reminded the participants at the conference, the majority of whom came from countries outside Africa, that inevitably the development objectives of every Third World country were to achieve the same living standards for the majority of their people as were enjoyed by the majority of the people in the more developed countries. In his view, AT as generally understood, is an interim solution.

This, of course, is a very valid argument. In a world which clamours for economic justice and help for the poorest of the poor, there is no logic in maintaining two standards, one for the haves and one for the have nots. But as the Brandt Commission has been at pains to point out, this gap which is widening all the time, can only be closed by drastic voluntary changes in the world's economic systems. Looking at the controlling forces which govern our economic systems, there would seem to be little hope of voluntary change unless more notice can be taken of the non-material values of life, so that economics, in the words of Schumacher, might find a human face. It is to be hoped that the powers which are exerted so forcibly to maintain economic advantage will be relaxed when more attention is paid to the basic wisdom which was expressed 2,000 years ago in the words: "If anyone has material possessions and sees his brother in need but has no pity on him, how can the love of God be in him?"

Peter Stern

GROUNDWATER POLLUTION

Research Needs in Modelling Contaminant Transport

Report on a Workshop at the University of Newcastle, 10-11 September 1984

A stimulating and useful workshop was recently held in the University of Newcastle at the invitation of the new Professor of Water Resources Engineering, **Enda O'Connell.** The workshop followed on from the successful short course on "Groundwater Flow and Pollution" in the previous week. The course had been given by **Professor Jacob Bear** of the Technion, Israel, and **Dr. Allen Shapiro** of the USGS, both of whom stayed on for the workshop.

The 18 other workshop participants came from water authorities and a variety of UK research institutions. It was a pity, but not a surprise, that none of those invited from the private sector could attend.

During the first day and a half, various participants made informal presentations of recent research and favourite theories. The audience cross-examined each author vigorously but found few flaws. The last afternoon was used to review what we had learnt and what research needs had been identified in the discussions. The review took the form of a series of statements; they are not intended to summarise the whole subject of contaminant transport modelling.

Management The objective of modelling contaminant transport is to supply information to management.

We need to be more aware of the role of hydrogeological predictions in the management process so that we can make more useful contributions.

Management and forecasting models should be merged more often.

Physics, chemistry and biology of flow and contaminant need to be better understood so we can make adequate conceptual models and so develop appropriate equations.

Mathematical and analytical solutions are always superior to numerical methods, if the equations can be developed and solved.

Numerical Methods A wide variety of methods, which will suit most situations, are readily available as algorithms and are often coded for computers.

New algorithms may be needed for a few special cases.

New methods are needed for high Peclet numbers (when advection dominates over dispersion); particle tracking methods appear useful here.

The choice of numerical method is problem dependant; in particular advection dominated transport must be identified.

Uncertainty and sensitivity analyses These should be incorporated in any modelling study.

Probabilistic methods and stochastic modelling are useful.

Simple and efficient models are needed to carry out the many trials for sensitivity analyses.

We need ways to describe the spatial variability of hydrogeological parameters.

Inverse methods These are numerical techniques to estimate aquifer properties or recharge from piezometric data.

There is a need for more efficient inverse methods.

Inverse methods should allow us to take more formal account of uncertainty.

Existing pollution plumes provide a wealth of information. More effort should be made to understand and model them.

Model validation There are not enough well documented, large scale field experiments or incidents for use in validating models.

Such experiments need to be carefully controlled and measured, with special attention to the sources and sinks of contaminant.

A catalogue of suitable experiments would be useful.

Dispersion Is scale dependant, that is dispersion coefficients increase the further a contaminant moves.

Scale dependance causes severe problems of measurement and modelling of transport at the field scale.

Need to reconsider the conceptual basis and decide (a) if it really Fickian (b) how scale dependance can be tackled.

More field determinations of coefficients are needed.

Dispersion measurements in the field should have the tracer converging towards a pumping borehole so that mass balances can be checked.

Sources and sinks for chemical and biological processes are not understood well enough to quantify them for modelling. Research is needed to improve extrapolations from laboratory to field.

Fractured rock Research is needed into solute transport in single three dimensional fractures and later into 3-D networks of fractures.

Data acquisition How can we improve the way in which we decide where to put the next point for data gathering?

Field experiments need to be linked with a conceptual model of the system for maximum benefit.

Hydrogeological and engineering judgment could be applied more consistently in data scare situations but new methods are needed; computer based "expert systems" should help.

Research organisation Research into flow and contaminant transport modelling in the UK is fragmented, with no one centre of excellence.

Too much research is done through contracts and consultancy: a general research budget is needed to fill the gaps and support fundamental work.

The International Groundwater Modelling Centre has opened a new European Centre at Delft, Holland.

David Lerner

Challenges in African Hydrology and Water Resources

International Symposium, Harare, Zimbabwe, 23-27 July 1984

About 150 hydrologists from most countries in Africa, and from some in Europe and North America met in Harare under the aegis of the International Association of Hydrological Sciences (IAHS), UNEP, WMO and UNESCO to discuss the continent's problems in hydrology and water resources. The Symposium was opened by the Prime Minister of Zimbabwe, the Honourable **R.G. Mugabe,** who reminded the participants of the problems of water supply faced by the growing population and how these were being exacerbated in his country by the continuing drought. Responding in his capacity as Secretary General of IAHS, **Dr John Rodda,** IH, thanked the Prime Minister for the generosity of his government in hosting the Symposium and presented him with a bound copy of the proceedings to mark the event.

The Symposium addressed the two different problems of groundwater and soil erosion and sediment transport. **Dr Steve Foster** and several other BGS hydrogeologists contributed extensively to the first of these topics in terms of exploration, development and modelling. **Ian Strangeways** (IH) discussed low cost hydrological data collection and there were several other UK contributions, particularly to the debate on measuring soil loss and reservoir sedimentation. In conclusion the Symposium made a number of recommendations to the UN bodies for inclusion in their future programmes.

WMO PUBLICATIONS

We have been asked by the World Meteorological Organization to advise potential purchasers of WMO publications that they are happy to put organisations with a hydrological interest on their mailing list to receive free copies of the WMO Publication Catalogue.

Part 4.8 of this catalogue lists publications dealing with hydrology, hydrometeorology and water resources, indicating the language in which they are printed.

Howard Penman – A Tribute

In memorium
DR HOWARD LATIMER PENMAN,
FRS OBE

The death occurred on 13 October of the British hydrological community's most renowned pioneer. A leader in the "art" of evaporation assessment for so long, the name of Penman is known worldwide coupled with that famous formula that allows calculation of the potential evaporation from an open water or a well watered grass surface, using only routinely measured climatological variables.

Penman graduated in Physics from the University of Durham and after a short spell at the Shirley Institute was appointed to the Physics Department, Rothamsted Experimental Station, in 1937. Following the war years he returned to Rothamsted to publish his classic paper "Natural Evaporation from Open Water, Bare Soil and Grass" in 1948. He was appointed head of the Physics Department in 1954 and was elected to Fellowship of the Royal Society and awarded the OBE in 1963. He retired in 1974.

Penman's work is remarkable in that its sound physical basis provides a permanence not possessed by many of the other so-called evaporation formulae. His basic formulation for estimating evaporation from diverse surfaces, has stimulated an extensive scientific literature; despite attempts to improve, refine and extend its application, Penman's original publication is still relevant today. His work is of great significance to agriculture, but of even greater importance to hydrology and water resources, for it made possible, for the first time, the computation of the water balance of a catchment with precision. Penman, although not himself a hydrologist, made the greatest single contribution to hydrology since the Second World War. Subsequently, he was heavily involved in international hydrology, through the UNESCO International Hydrological Decade. In the UK he was one of those responsible for the founding of the DSIR Hydrological Research Unit and played an important part in developing the Unit into NERC's Institute of Hydrology.

John C. Rodda

Forthcoming Events

International Meetings

1985
18-23 August
"International Workshop on Hydrologic Applications of Space Technology", Cocoa Beach, Florida.
Organised by IAHS and WMO. Preliminary registration and offers of papers by 30 November 1984 (details from WMO, Geneva). Travel package by American Express – details from D. Melfi, 01-637 8600.

19-23 September
International Symposium "Scientific Basis for Water Resources Management". Jerusalem, Israel.
Further details from Israel Association of Hydrology, PO Box 6381, Jerusalem.

1986
2-10 July
2nd Scientific Assembly, IAHS
Organized by the Water Resources Research Centre, Budapest, Hungary.

Four symposia:
S1 Modelling Snowmelt-induced Processes
S2 Conjunctive Water Use
S3 Monitoring to Detect Changes in Water Quality Series
S4 Integrated Design of Hydrological Networks

Four workshops:
W1 Physics and Stochasticity in Hydrology
W2 Geomorphology and Numerical Modelling of Catchment Behaviour
W3 Recent Developments in Flood Routing
W4 Hydrology 2000

Call for papers
Authors are invited to submit extended abstracts (2-3 pages) by **30 March 1985.** Notification of acceptance/rejection by 1 July 1985. Receipt of full papers by 30 October 1985.

Further details:
IAHS Secretary General
c/o Institute of Hydrology
Wallingford
Oxon OX10 8BB

PROGRAMME CHANGES

The BHS Midlands Section meeting on 21 November has been rescheduled for Wednesday, **5 December.**

Peter Walsh, Andrew Skinner and Alan Lambert (under the Chairmanship of Mike Hamlin) will be discussing how their operating systems have stood up to the stress of this year's drought.

Further details from Richard Wood (STWA).

The Pennines Hydrological Group meeting on 9 January has been moved to **16 January.**

"The assessment of hydraulic performance using the WASSP model, in sewerage rehabilitation strategy".

S. Roberts (NWWA) and G. Catterson (Bolton MBC). Meeting starts at 2 p.m. at Dawson House; please advise Tony Lewis (NWWA) if you will be attending.

Courses

14-17 January 1985
Tadley Court, Hants.

Use and Application of the Flood Studies Report.

Aimed at engineers, hydrologists and others who estimate floods on rural, partly urban or reservoired catchments.

The course will teach techniques for flood peak and hydrograph estimation based on the Flood Studies Report and its Supplementary Reports and associated guides. Lectures and demonstrations provided by Institute of Hydrology staff will be complemented by case study and discussion sessions.

Tadley Court is one of five residential training centres run by the Water Industry Training Association.

Contact: Denise Betts, Water Industry Training Association, Tadley Court, Tadley, Near Basingstoke, Hants RG26 6TB.
07356-3011.

Copy date for Issue No. 5 – Friday, 4th January 1985.

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