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UNIVERSITY RESEARCH ... Part II

Geography Dept., Bristol

The Department of Geography at Bristol has been a major centre of research in physical hydrology for many years. The work of Malcolm Anderson, Eric Barrett and Pete Smart has been augmented by the recent appointment of Professor John Thornes to the headship of the department, by Sheila Ross in the field of water chemistry and Andrew Harrison in remote sensing. This has resulted in the establishment of a major research centre for all aspects of physical hydrology – currently comprising some 15 graduate students/research assistants.

Over the last eight years or so **Malcolm Anderson** has built up a research group of nine research students and research assistants. the basic thrust of this group has been the development of models of hillslope hydrology designed to reflect hydrological process behaviour in a manner compatible with engineering models to which such schemes need ultimately to be coupled for design purposes. Both UK and overseas agencies are funding this group's research to a level that at the present time exceeds £1¼M. The work is centred on four main fields: development of coupled hydrology/slope stability models, snow hydrology, ungauged catchment forecasting and soil moisture models for trafficability.

A major emphasis is the development of soil water hydrology models for enhancing the design criteria for cut slopes in the Tropics (**Martin Kemp** and **David Lloyd**). A field programme is underway in Malaysia to provide data for validation and involves the co-ordination of the efforts of the Malaysian Public Works Department and the Transport and Road Research Laboratory. In addition, a study of piezometer installation design using finite element techniques has been recently completed. This study has been successful in specifying the filter/ceramic/soil properties and dimensions that are required for Casagrande piezometers, to ensure non-restrictive flow into the piezometer. The finite element solution and a method of fragments solution for the problem were successfully compared.

A second major area relates to hydrological forecasting and involves two studies. Firstly, the development of models for flood forecasting in ungauged catchments (**Laura Singleton**) with the main emphasis being the treatment of flow routing in river channels and over flood plains to predict flood inundation. This study is centred on a West German watershed database where a number of moving storm studies have already been completed. Currently the main research effort is in modifying the out-of-bank flow equations. Secondly, a collaborative study with the Cold Regions Research and Engineering Laboratory, New Hampshire, USA, is being undertaken (**Katherine Sambles**) on the development of a spatially distributed snowmelt model. Both ground truth mapping and SPOT imagery of the W3 Sleeper's River watershed will be used for model validation. Modelling of near surface soil moisture and shear strength for trafficability (**Janet Cochrane**) is nearing completion with the nesting of one and two dimensional soil water models. Physically-based moisture/strength models have been developed and currently field trials of the model are being undertaken.

Major studies have been undertaken with the Institute of Hydrology and the NERC out of Water Resources Systems Research at Newcastle University on the IHDM and SHE models.

In addition to developing the research group, Malcolm Anderson initiated the new Wiley journal *Hydrological Processes*.

In 1983 the University of Bristol, determined to increase its involvement in the fledgling science of environmental remote sensing, established a new Remote Sensing Unit with **Eric Barrett** as Director. The RSU is housed in the basement of the Geography Department, and is now part of the Geography Cost Centre following the recent resource reallocation exercise.

Equipped with an I²S System 575/VAX-11-750 image processing system, TDS HR-20/OPUS-PCAT digitizing system, Ramtek videorecorder, and ancillary equipment, the Unit has recently received an I²S System 100/LSI-11-23 image processing system on loan from the US National Oceanic and Atmospheric Administration. this is the latest support enjoyed by the RSU under its Memorandum of Understanding with NOAA for co-operative research. It is believed that the RSU is the only non-US university institute with such a link. Historically it has come about because of Dr Barrett's long-standing links with NOAA's Satellite Applications Laboratory in Camp Springs, Maryland, primarily in respect of his satellite rainfall

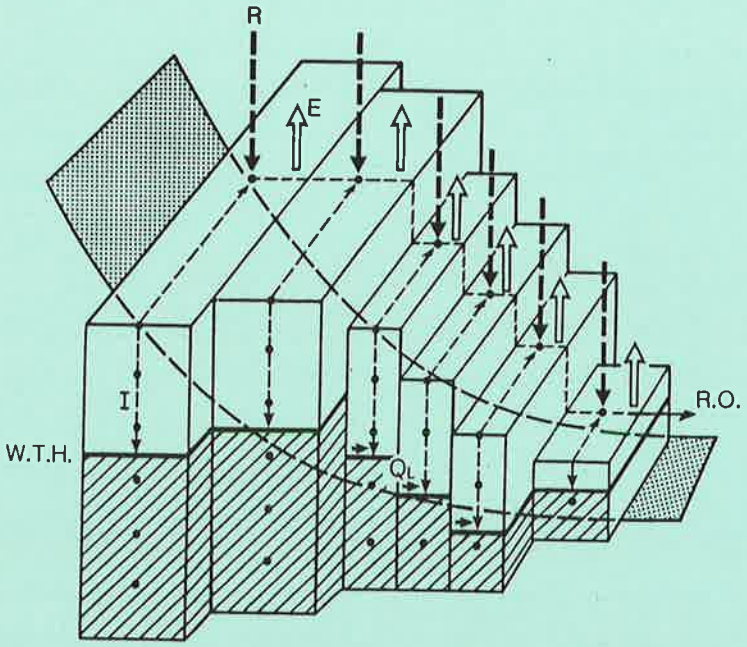


Illustration of the combined slope hydrology and slope stability model structures being developed by Anderson, Kemp and Lloyd.

monitoring research. Eric is an acknowledged expert in this field, and has co-authored the only integrated text on the topic (Barrett and Martin, 1981).

Today, the RSU maintains a strong interest in the use of satellites for improved rainfall monitoring, particularly in the form of newly-available passive microwave data to complement visible and infrared imagery for improved algorithm performance. In this, Dr Barrett is being assisted by lecturer colleagues **John Bailey** and **Giles D'Souza**, research assistant **Clare Power** and two NERC research students. John Bailey is also investigating possible improvements to the potential of satellite data for the MORECS evaporation bulletins as used by the Meteorological Office. This enquiry is part of a broader 3-year project funded by the Department of the Environment and managed by **Reg Herschy** (formerly of the DoE, now Honourary Research Fellow in the RSU), seeking to formulate operational satellite-based algorithms to monitor several hydrological variables in the UK, with special emphasis on the Highlands of Scotland. Snowcover is, therefore, now receiving particularly close attention in the RSU, with the aim of developing a method for weekly snow area mapping from NOAA satellite imagery with a ground resolution of approximately 1 km. **Richard Lucas** is the research assistant involved with this, under the direction of **Andrew Harrison**, whose other interests include urban and rural land mapping and monitoring by Landsat and SPOT, plus the development of Geographic Information Systems – within which hydrological parameters may be considered to be particularly dynamic layers.

The RSU has considerable experience overseas, having given advice or support to a number of national governments, especially in Southern Europe, Africa and the south-western rim of Asia. Today much attention is focussed on the development of a range of satellite hydrology monitoring algorithms for operational use locally, in or near real time, based on the new generation of low-cost satellite data-reception systems supported by micro-computers (IBM-PC or look-alikes). Key staff members in this area are **Michael Beaumont** a computer-aided design specialist transferred to the RSU from the old Department of Architecture in 1984, and **Tim Richards**, the RSU Systems Manager.

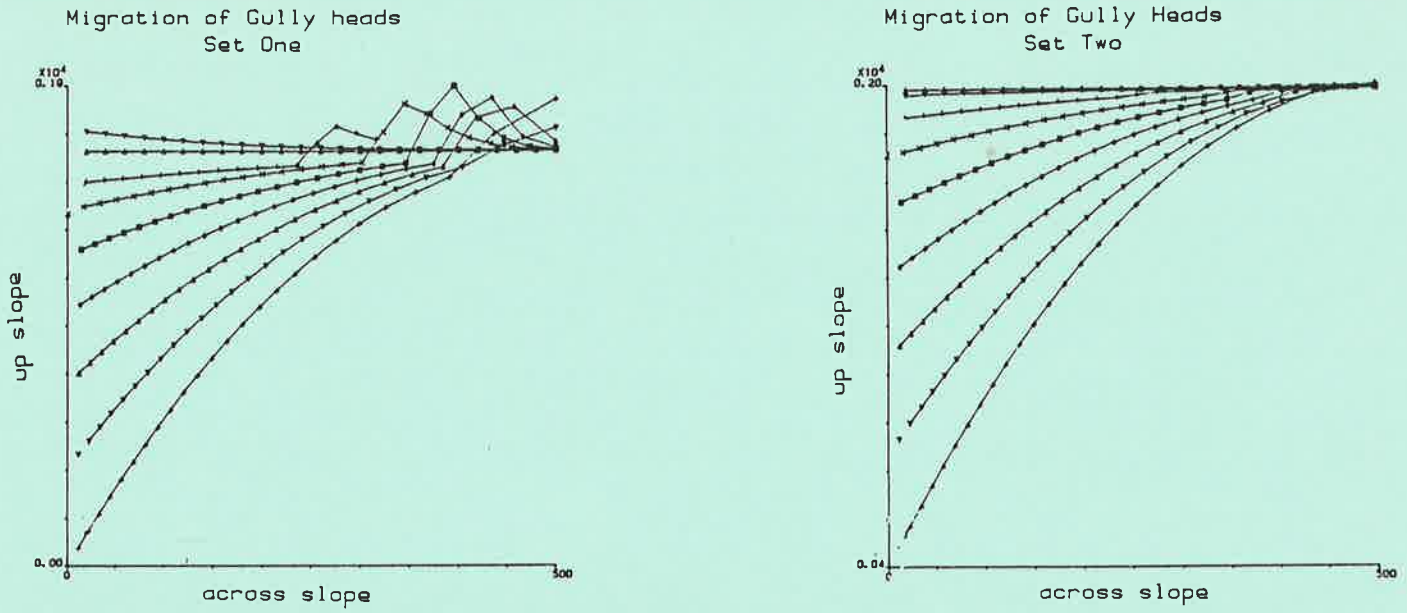
We believe that satellite remote sensing will have an increasingly important role to play in hydrology and water management in the near- to mid-term future as satellite systems become more capable, algorithms more customized, and as conventional data (from many regions of the world) continue to become more scarce and unreliable.

Another area with a long tradition of research at Bristol is that of Karst hydrology (**Pete Smart**). To a major degree this has been stimulated by the proximity of the Mendip Hills which provide an important regional water supply. Co-operative work with both Wessex Water Authority and Bristol Waterworks have led to a detailed understanding of the recharge, storage and groundwater flow processes in the Carboniferous Limestone aquifer. Many of the concepts and techniques developed at Bristol have been adopted elsewhere, for instance in recent work in the United States on groundwater monitoring in carbonate terrains. Water tracing using both natural (inorganic ions, radon, stable isotopes) and artificial tracers (predominantly fluorescent dyes) has been a particular specialism, including the development of tracer techniques, and their application to problems such as the evaluation of landfill sites. Current major research includes work on aquifer heterogeneity and its effects on the modelling of aquifer dewatering for large scale quarry operations, production of turbidity events at springs used for supply, and modelling of historic water quality changes in relation to land-use practices (**Steve Hobbs**).

Comparative studies are also being undertaken in other carbonate aquifers to obtain a better understanding of the interrelations between aquifer configuration, lithology and structure, and the development of dissolutional porosity in the form of fissures and conduits. This work has important implications for both resource protection and the mode of exploitation of groundwater resources. An understanding of the hydrochemistry of carbonate aquifers is also important in explaining the diagonesis of carbonate sediments, and the prediction of porosity in oil reservoirs. Recent work in the Bahamas supported by Shell Exploration and Production, UK (**Pete Smart** and **Fiona Whittaker**) has included examination of the chemical processes occurring in the modern "mixing zone" between the fresh and underlying saline groundwaters. Work is also underway to determine the extent of trans-island flows of saline groundwater, and their geochemical effects. Chemical processes have also been important in studies of the environmental impact of open cast coal mining, and studies of the abandoned coal mines in the Forest of Dean with Severn Trent Water Authority.

The hydrology of peat moors and peat bogs is being studied by **Sheila Ross** in collaboration with the Nature Conservancy Council. Two topics of particular interest are the effects of ditch and streamwater quality of peatland underdrainage and subsequent fertilizer application for agricultural use. Fundamental to this work is the study of seasonal hydrological response in both drained and underdrained peat, as influenced by water management practices such as ditch penning and ditch pumping. Apart from the solute dynamics which accompany changes in redox potential, particular attention is being paid to the fate of nitrate fertilizers applied to both peat moors and clay levels. ^{15}N tracer experiments are being used to monitor the transformation and transport of $^{15}NH_4$-N and $^{15}NO_3$-N through peat and into watercourses. Laboratory simulations in combination with field monitoring are being used to test the effectiveness on improved ditchwater quality of ditch management practices, such as creating submerged shelves or "berms" or of maintaining ditch fringes of emergent vegetation such as reeds.

Finally, **John Thornes**, who has recently joined the Department, has brought an interest in the hydrology and geomorphology of semi-arid environments and tropical rain forests. For the former, he has research students working on the theory of gully headwall recession (**Anne Marchington**), subsurface piping in agricultural terraces (**Glenn Watts**) and the action of hydrologically-driven geomorphic processes on neo teotonic fault-scarp erosion (**Ian Stewart**). In addition, an NERC-funded research project is investigat-



Anne Marchington is using a finite difference simulation solved by characteristics to evaluate a theoretical model of gully-head migration developed by John Thornes. The diagram shows the migration of different gully-head shapes on a 12 m and 6 m slope, with bifurcation occurring in the former.

ing litter and soil organic matter in relation to overland flow, soil moisture and soil erosion in south-east Spain (**Carolyn Francis**). John Thornes has been awarded a major EEC research contract with the Universities of Murcia (Spain), Lison and Evora (Portugal) to look at the recent and historic impacts of extreme drought and flood events in the Ibeirian Peninsula. Bristol's role will mainly involve modelling mediterranean ecosystems under extreme drought stress and their impact on soil erosion and run off. In the tropics John Thornes is working with **Stephen Nortcliff** (Reading Soil Science) and Sheila Ross on subsurface water movement in forest environments and on the relation between organic matter decomposition and water and sediment runoff in forested and deforested areas. This extends the recent work done by **Jane Brandt** and John Thornes on the kinetic energy of canopy throughfall at Reserva Ducke, Manaus. These ecological aspects of hydrological and geomorphological processes are being investigated in the context of a general theoretical approach to vegetation-erosion competition in semi- and tropical environments.

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Hydrological Data: UK 1985 Yearbook

The recent publication of the 1985 Yearbook in the Hydrological data: UK series brings to five the number of Yearbooks issued since the series was launched two years ago. The delay between data collection and its eventual publication has been substantially reduced and it is anticipated that the 1987 Yearbook will achieve the first "following year" publication date since the Surface Water Yearbook of 1964.

In common with the earlier editions the 1985 Yearbook provides a review of hydrological conditions during the featured year and brings together the principal data sets relating river flow, groundwater levels and rainfall for the United Kingdom. The data retrieval services by which such data may be made available from the national archives are also described.

In addition, two special articles are included to celebrate the fiftieth anniversary of the formation of the Inland Water Survey – in 1935. In the first, **Martin Lees** (Institute of Hydrology) traces the history of water surveying in the United Kingdom. This feature provides a valuable perspective of a time when the acquisition, archiving and use of hydrological data has assumed a rare topicality with the publication of Government proposals concerning the creation of a National Rivers Authority. The proposals invite comments on where the responsibility should lie – following the privatisation of the utility functions of the Water Authorities – for the collection and processing of hydrometric data and the maintenance of the national river flow archive. Reviews of such activities have become a national pastime in, and beyond, the hydrological community. The founding fathers of water surveying in the UK were convinced advocates of the systematic and co-ordinated appraisal and monitoring of water resources with regard to both quantity and quality. Unfortunately, legislative and administrative arrangements have, for the most part, ensured that we remain some way from maximising the benefits that could accrue from a unified approach to hydrometric surveying. Perhaps things are about to change!

The second special article, contributed by **Alan Werrity** (University of St. Andrews) examines the pioneering work of Captain W.N. McClean in Scotland with particular reference to the creation of the early hydrometric data sets now housed at the University of St. Andrews. From 1913 Captain McClean operated a hydrometric network in eastern Scotland. He established many of the ground rules for routine river flow measurement and by maintaining the network at his own expense created a precedent which will doubtless be exercising a number of mind at present!

Copies of the 1985 Yearbook may be obtained from: The Surface Water Archive Office, Institute of Hydrology, Wallingford, Oxon OX10 8BB.

WORLD METEOROLOGICAL ORGANIZATION

What is WMO?

The World Meteorological Organization (WMO) is a specialized agency of the United Nations system. The World Meteorological Congress is the supreme body of the Organization and once every four years brings together the representatives of all Member countries to determine general policies for the fulfilment of the purposes of the Organization. Membership of the Organization has now (September 1987) reached 159, consisting of 154 States and 5 Territories, each maintaining its own Meteorological or Hydrometeorological Service. The Executive Council of WMO is composed of 36 directors of national Meteorological or Hydrometeorological Services serving in an individual capacity; it meets once a year to supervise the programmes approved by Congress.

Much of the work of WMO is carried out through the Organization's eight technical commissions, each of which deals with a specific field of meteorological or hydrological interest. Regional matters are handled by six regional associations.

Through these bodies the Organization is able to make maximum use of the collective experience and scientific knowledge of its Members. They all participate in the work of the regional associations and may nominate experts to the technical commissions.

HYDROLOGY AND WATER RESOURCES PROGRAMME

The commitment of WMO to hydrology has been designated by Congress as the Hydrology and Water Resources Programme (HWRP). The programme concentrates on operational hydrology and on water-resource assessment in general. The overall objective of the programme is to ensure the assessment and forecasting of the quantity and quality of water resources both for different sectoral uses and for hazard mitigation.

The HWRP aims to achieve this object by promoting world-wide co-operation in the evaluation of water resources and in the development of these resources through the co-ordinated establishment of hydrological networks and services, including data collection and processing, hydrological forecastings and warnings and the supply of meteorological and hydrological data for design purposes. The three components of the programme are:

- The Operational Hydrology Programme;
- The Programme on Applications and Services to Water Resources; and
- The Programme on Co-operation with Water-related Programmes of Other International Organizations.

Each of these programmes is discussed later in more detail. In addition, hydrological elements are embedded in several other WMO Programmes. Particular examples are the hydrological components of the Tropical Cyclone Programme and the World Climate Programme. These are closely co-ordinated with the appropriate components of the Hydrology and Water Resources Programme.

Management of the programme

The Operational Hydrology Programme is planned and executed under the auspices of the WMO Commission for Hydrology (CHy) which meets every four years to review past activities and to decide on the details of the future programme in accordance with the overall policy and guidance of WMO Congress and Executive Council. CHy also reviews activities under the other two component programmes but responsibility for their implementation lies elsewhere. Activities under the second component programme, Applications and Services to Water Resources, are implemented in accordance with the decisions of the Executive Council and in co-ordination with the other WMO Progammes concerned. The third component programme, Co-operation with Water-related Programmes of Other International Organizations, is based on agreements with other international organizations and the activities concerned are undertaken on the basis of the decisions of the Executive Council and the Secretary-General.

The HWRP incorporates and supports a wide range of activities related to education and training in hydrology. In addition, a substantial proportion of the WMO technical co-operation activities are undertaken in the field of operational hydrology. Regional aspects of projects covered by the HWRP are implemented principally by the six regional associations of WMO. In the WMO Secretariat in Geneva, the Hydrology and Water Resources Department provides the necessary professional support for matters related to hydrology and water resources.

OPERATIONAL HYDROLOGY PROGRAMME

The Commission for Hydrology

The Operational Hydrology Programme (OHP) is carried out mainly through the Commission for Hydrology (CHy) in close collaboration with other WMO commissions. Two hundred and four experts from 108 countries currently serve on the commission. Some come from the national Meteorological or Hydrological Services of Member countries. Others are connected with universities or government departments dealing with hydrology. The Commission for Hydrology provides an excellent forum for scientists from the different services to discuss mutual problems and to prepare guidance material. The Commission benefits from the co-ordinated efforts of some of the world's leading hydrologists. CHy implements its technical programme principally through a system of working groups and rapporteurs. There are currently four working groups of the Commission and ten independent rapporteurs. The Commission has embarked on a programme for the coming years, which aims to further the development of national Hydrological Services. Among other activities with high priority are: the design, evaluation and operation of networks for measuring elements of the hydrological cycle; improvement and standardization of instruments and methods of observation for hydrological purposes; hydrological data transmission, processing and retrieval; design data for projects; hydrological forecasting; and the contribution of operational hydrology to the problems of drought, desertification and climate variability.

The fruits of this work are often found in the exchange of information and advice between members of CHy and other national experts. Meetings of experts are called, training courses organized and technical symposia are convened. In more concrete terms the results of most projects are published, principally as a series of WMO Operational Hydrology Reports covering all aspects of operational hydrology.

The regional dimension

The six WMO regional associations have each established their own working groups on hydrology that aid the co-ordination of regional activities in operational hydrology and are responsible for regional aspects of the OHP.

A major effort in technology transfer – HOMS

The first and major concern of WMO in the water field is to aid the work of those national or regional agencies which are responsible for operational activities. The meetings and publications resulting from the OHP offer them valuable guidance and advice, but when it comes to operational practice in the field and office, what is needed is the acquisition and installation of the hardware and software of hydrological technology. In 1979 WMO Congress approved the concept of a system for the institutionalized transfer of hydrological technology. This concept was developed by CHy into the Hydrological Operational Multipurpose Subprogramme (HOMS) which has now been operating very effectively for over six years.

HOMS provides a method for the transfer of the technology used by hydrologists. This technology usually takes the form of hydrological instruments, technical manuals or computer programs. These materials have been made available by the Hydrological Service of the Member countries of WMO from the techniques that they themselves use in their normal operations so ensuring that the technology transferred is ready for use and works reliably.

Structure of HOMS

The technology available through HOMS is provided in the form of separate HOMS components. Typical examples of components include the drawings necessary to build a gauging cableway, a set of computer programs to maintain a computerized bank of hydrological data or a manual on methods of estimating probable maximum precipitation (PMP). The components available (approximately 350 currently) are each described in a two-page summary description written to a standard format. These summary descriptions are published in the HOMS Reference Manual (HRM), the basic document for HOMS.

HOMS is organized as a co-operative effort of the Members of WMO. Those Members wishing to participate in HOMS do so by designating a HOMS National Reference Centre (HNRC), usually in the national Hydrological Service. To date, some 90 Members have designated HOMS National Reference Centres. International activities under HOMS are supervised and co-ordinated by the Steering Committee for HOMS that works within the framework of the WMO Commission for Hydrology. Secretariat support is provided by the HOMS Office in the Hydrology and Water Resources Department of the WMO Secretariat in Geneva.

APPLICATIONS AND SERVICES TO WATER RESOURCES

The Programme on Applications and Services to Water Resources brings together hydrological and meteorological activities in support of water-resource development. The activities under this programme constitute contributions to various meteorological and climatological programmes of WMO that have important hydrological components, such as those of the Tropical Cyclone Programme (TCP) and the World Climate Programme (WCP).

The structure of this programme reflects the basis on which it has been defined and has evolved. In particular, there are a number of activities in which the major emphasis lies elsewhere but where the HWRP is called upon to make a major input with regard to aspects concerning operational hydrology. This programme therefore encompasses the hydrological aspects of food and energy production and water supply and the forecasting and mitigration of effects of natural hazards with hydrological aspects. The last of these offers basic support to the hydrological element of the TCP. It is also of relevance to the WCP, but support to the WCP is primarily covered by activities relating to hydrological aspects of climate variation and of weather and environmental modification.

The destructive power of typhoons and hurricanes

Work under the TCP centres on five regional bodies, one for each of the five major geographic areas that experience tropical cyclones, or typhoons or hurricanes as they are called in different parts of the world. These bodies play an important role in co-ordinating activities designed to improve the forecasting of tropical cyclones and so reducing the heavy toll of life and destruction that they exact. The principal direct cause of this destruction is flooding. The hydrological component of the TCP therefore encompasses collaborative efforts to install, monitor and upgrade flood forecasting systems and to assess the risk from flooding in threatened areas.

Climate and water: a close and vital link

Water-related activities under the WCP are considerably more diverse in character. They include the compilation of a global set of runoff data, the development of hydrological models which can be linked with models of the global climate, studies of the impact of future climate variability on water resources and the use of climate information in water supply forecasting. The whole of the WCP is inter-disciplinary and projects in the water field are planned, and on occasion undertaken, in conjunction with other international organizations, most notably Unesco and the International Association of Hydrological Sciences (IAHS).

CO-OPERATION WITH WATER-RELATED PROGRAMMES OF OTHER INTERNATIONAL ORGANIZATIONS

As a follow-up to the UN Water Conference, WMO takes the lead, jointly with Unesco, in international activities relating to water-resource assessment, involving the assessment of both surface water and groundwater resources with respect to their quantity and quality. In addition to the specific responsibilities shouldered by WMO within the UN system, a large number of other international programmes call upon expertise in operational hydrology that it is the duty of WMO to supply. The response of WMO in this regard is made under the Programme on Co-operation with Water-related Programmes of Other International Organizations.

A major aspect of this component programme is the collaboration with Unesco. This collaboration involves numerous activities of which one of the most important is a project to increase the capability of Members to apply advanced methodologies and technologies in the assessment and management of their water resources. Support is also provided to the International Hydrological Programme (IHP) of Unesco. Intergovernmental conferences are periodically convened jointly by the two organizations to ensure close co-ordination. Recommendations of these conferences are submitted to WMO Congress which sets the general guidelines and policy for WMO's future collaboration with Unesco.

The involvement of the Organization in broader inter-agency activities within the UN system involves collaboration with the United Nations, its Economic Commissions and UNEP as well as with, for example, WHO, FAO and IAEA.

Co-ordination of inter-agency activities in the water field is considered periodically by the Economic and Social Council of the United Nations and its Committee on Natural Resources. Co-ordination at inter-secretariat level is under the Administrative Committee on Co-ordination and its Inter-Secretariat Group for Water.

Co-operation is also maintained with organizations outside the United Nations system. These include the International Association of Hydrological Sciences (IAHS), the International Organization for Standardization (ISO), the International Association of Hydraulic Research (IAHR) and the International Institute for Applied Systems Analysis (IIASA) and a number of other non-governmental organizations. Activities here range from the provision of guidance material to the co-sponsorship of technical meetings covering subjects concerned with operational hydrology. Such co-operation is based on a series of working agreements approved by WMO Congress that permit the Organization to support the activities of these other bodies and to gain from their expertise and from involvement with the very broad and diverse range of projects they undertake.

EDUCATION AND TRAINING

As hydrology is a separate discipline, training activities of WMO in the field of hydrology are clearly identifiable. Training may be undertaken at different levels: in-service training, training in educational institutions, workshops, seminars, on-the-job training and the short-term residency of experts.

The Organization grants short-term and long-term fellowships for study in operational hydrology that allow individuals to study any of a number of specialized topics. International or regional training courses are also conducted by the Organization on specific topics in operational hydrology. The aim of the Organization is to support and, where appropriate, augment the training activities in hydrology undertaken by countries or by other international bodies.

TECHNICAL CO-OPERATION

The economic importance to any country of a planned water policy is obvious. No nation can plan the best use of its water resources unless it has both qualified staff and the essential facilities to make use of these resources. Countries where facilities are absent or inadequate are greatly disadvantaged. To remedy this situation, WMO has for more than 30 years been providing substantial assistance to developing countries under its technical co-operation programme. The funds to finance these activities come from four sources: the United Nations Development Programme (UNDP); trust funds made available either by the country concerned or by a third party; the WMO Voluntary Co-operation Programme (VCP); and, to a limited extent, the WMO regular budget.

About one-third of the total technical assistance provided through WMO (about US$20 million per year) is in hydrology and water-resource development. Technical assistance activities are organized in the form of projects in which the partners are the country or countries concerned, the donor of funds and WMO. Such projects may relate to the strengthening of Hydrological Services; water-resource assessment surveys; hydrological observing networks and their operation; river flood forecasting; application of hydrological and meteorological data to water management; training of hydrological and hydrometeorological personnel. In the implementation of technical assistance projects, WMO organizes expert missions, arranges for training of nationals, and supplies instruments and equipment. WMO carries out many small-scale projects commensurate with the technical and financial ability of the country concerned to both assimilate the assistance and to continue the operation of the techniques and facilities on its own after the project is finished. WMO also mounts large-scale projects each costing several million dollars and lasting up to ten years or more.

Arthur J. Askew

The River Floss Flood Alleviation Scheme

Pennines Hydrological Group Meeting – 14 October 1988

This well attended meeting, which was held in the impressive surroundings of York racecourse, took the form of a morning presentation of a paper, followed by a site visit in the afternoon. The paper, by A.W. Jones of Mott, Hay and Anderson covered a wide number of aspects of the Foss scheme, including hydrology, hydraulics and civil engineering design, along with other problems which had to be overcome. In the afternoon, the site visit to the scheme enabled progress to be viewed first hand, including the recently installed lifting gate.

The scheme was introduced by describing some of the hsitory of flooding in York and some of the measures which had been introduced to combat flooding. As a result of recent and severe flooding in York, a decision was taken to prevent flooding from the River Foss. Investigation into the causes of flooding in the Foss catchment soon showed that whilst channel capacity was sufficient to handle flooding from the Foss itself, the main cause of flooding was due to backing up from the main river Ouse.

A first stage in the design therefore, was to establish a level of defence for the scheme, based on a 100-year return period. Analysis of available level data for the Ouse at York was carried out, but this also revealed a significant trend in the annual maximum levels. Reasons for this trend were sought, including investigation of trends in upstream river flows and rainfall, as well as the reliability of the original records. No complete explanation was found for the observed trend in the Ouse data, but it was noted that the earlier records were of questionable reliability. With this in mind, subsequent analyses were only carried out on records from 1932 onwards. This suggested a design level of 10.1 m, to which a freeboard of 0.35 m was added.

The next stage in the design was a hydrological analysis of the Foss itself, to establish return period hydrographs. As there were no available records for Foss flows, the Foss hydrograph was synthetised using the Flood Studies Report Unit Hydrograph technique. Use was made of existing daily raingauge records in the catchment to check on the FSR values, revealing that FSR values were up to 25% higher than measured values. A decision was taken to use the measured values, giving a peak 100-year return period flow of 42 cumecs, which the Foss is able to pass, subject to River Ouse levels.

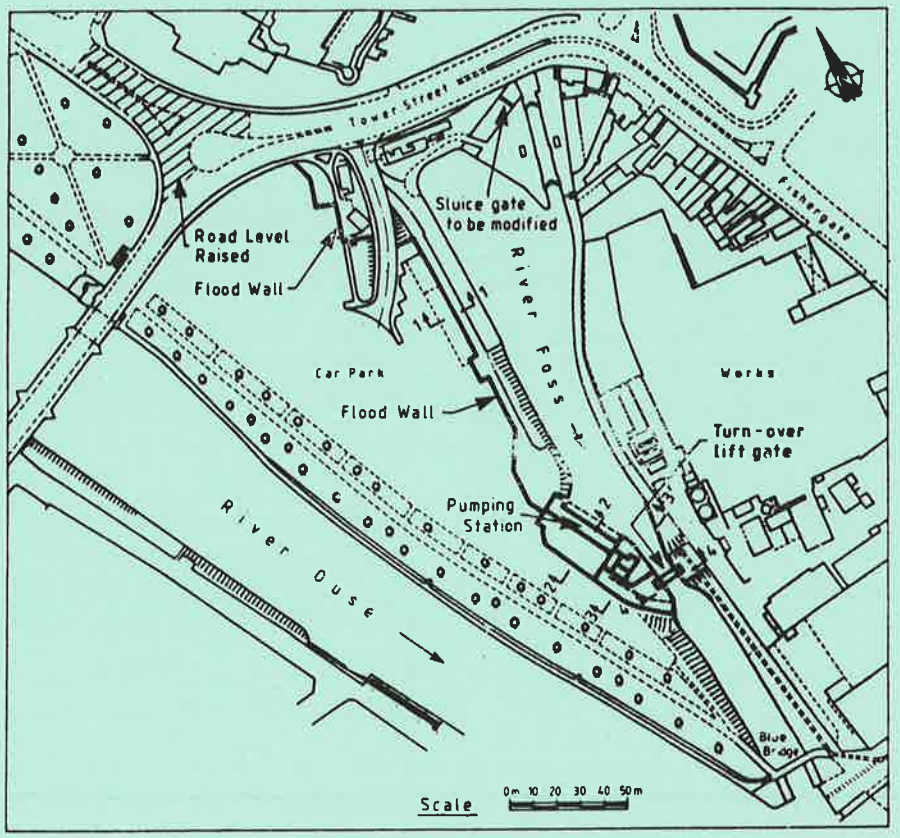
The probability of high flows occurring together in the Ouse and Foss was then used to derive the required pumping station capacity. An analysis of 113 events showed that a lower critical value of 29 cumecs applied when considering both systems together. Backwater analysis was also carried out for various combinations of flows. These again demonstrated clearly that the Ouse is the dominant factor in Foss flooding. At a level of 10 m in the Ouse for example, varying flows in the Foss had virtually no effect on water levels at various locations in the catchment.

Having calculated the design level for defences and the required pumping station capacity, various alternative strategies were investigated, including the raising of banks, barriers, pumping and storage/no storage situations. In capital terms the barrier and pumping without storage was the most advantageous, additionally avoiding a number of operational and aesthetic problems.

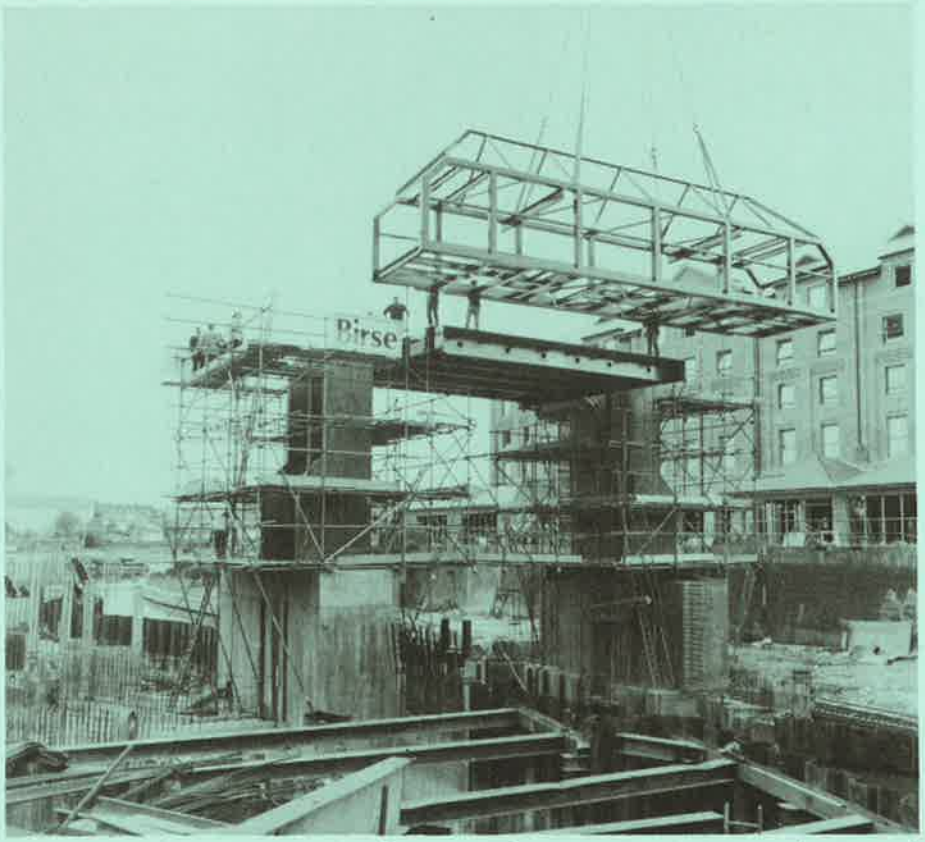
In choosing pumps for the scheme, it was initially thought that horizontally mounted automatic submersible pumps would be used and a scheme was designed accordingly, subsequently obtaining public approval. The pump capacity required meant that the scheme would have the largest capacity of submersible pumping in Great Britain. As the design progressed, the pumping station was then repositioned next to the barrier. In addition, a significant power supply risk was identified for the 2Mw required, necessitating the use of standby generators, which had to be located above maximum flood level. Pump design and discharge arrangements were also changed, switching to a vertical pump arrangement, with a site layout which prevented backflow. It was now proposed the station be manned and semi-automatic, requiring further buildings above maximum flood level.

Public debate then ensued on the revised scheme, but eventually by mid-1986 all necessary approvals had been obtained for the work. Use of an architectural model and photomontage techniques, coupled with sensitive architectural design were used to explain plans and ensure that they were in keeping with surroundings.

Having gained permission for the works, a



RIVER FOSS FLOOD ALLEVIATION SCHEME
PROPOSED WORKS



number of preliminary investigations were then carried out. These were:

i A site investigation of the subsoils. The makeup of the underlying strata was such as to allow the use of short, precast concrete piles.

ii An archaeological survey of the site. York archaeological trust were contacted at an early stage and several digs took place on site. These did not reveal anything of interest however; it is thought that the site could have originally been a rubbish tip!

iii Several hydraulic model studies were undertaken. The first was a 1:40 model from the Foss lock to the Ouse and was used to establish flow patterns, confirming that the alignment of the pump intakes was optimal. The second was a 1:16 model to check the effects of the inlet and discharge on the River Foss. It indicated that energy needed dissipating in the release culvert and to provide this, a step and trip arrangement was used. The third model was a 1:8 model of the pump chamber and discharge arrangements. This established that pressure and velocity distribution on the impellor was even, with a smooth flow of water over the discharge weir. In the pump design, facilities were made for pumping under test conditions. The pumps are to be simply mounted in a concrete structure, thus allowing easy maintenance, rather than being rigidly bolted.

In the design of the gate, consideration had not only to be given to the fact that the Foss is a navigation, but also that the gate would normally be clear of the water and would need to fit in with the environment. A lifting gate which pivoted horizontal when fully raised was finally chosen, with features of low overall height and low wind resistance also being considered. Extensive use is to be made of glazing and cladding to minimise the visual impact.

When out on site, it was possible to see a number of features of the scheme, including the 16 tonne gate which had been installed at the end of August. When installing the gate, it was wondered whether the one day which the heavy lift crane had been booked for, would be sufficient. In the event, all was completed by lunchtime!

Ed Bramley

Directory of British Hydrology

Various errors or omissions have been brought to the attention of the editor of the Directory and these will from time to time appear in *Circulation* prior to correction or inclusion in a future edition of the Directory.

Please note that the following additions should be made to the "Hydrologists in the Private Sector" section of the Directory.

1 Aspinwall and Company Limited
5 Swan Hill Court
SHREWSBURY
SY1 1NP
0743 231391

2 Wimpey Laboratories Limited
Beaconsfield Road
Hayes, MIDDLESEX
UB3 0LS
01 573 7744

Also an error was made in the printing of the telephone number of WRC Processes. The correct number is 0438 312444. There seems to be no truth in the rumour that the small company that was receiving many telephone calls meant for WRC is to apply for inclusion in the Directory as an associated organisation. The editor expresses apologies for any inconvenience that may have been caused.

Ian Cluckie

PRIVATISATION– The National Rivers Authority

In line with previous initiatives on behalf of the Society, the President has submitted comments to the Department of the Environment on the Government's proposals for a Public Regulatory Body in a Privatised Water Industry (the proposed National Rivers Authority).

Those members of the Society who attended the evening discussion on this topic during the National Symposium at Hull in mid-September will have the full text of the submission. In summary, for those who did not manage to get to Hull, the Society's comments relate principally to the two main issues of (1) land drainage and flood protection and (2) hydrometric networks, avoiding subjective comments on the wisdom or otherwise of the proposals but highlighting our concerns over operational needs.

In the case of hydrometric networks – a subject about which feelings sometimes run high – an attempt has been made to cover all aspects of the collection, use and value of hydrometric data, dealing separately with both short-term use in river basin management and the long-term strategic applications in planning and design.

Any members who would like a copy of the submission should contact Phil Johnson, Northumbrian Water, etc.

BOOKS

PMP

Manual for Estimation of Probable Maximum Precipitation – World Meteorological Organisation Operational Hydrology Report no. 1, Second Edition; published in 1986 by WMO, Geneva, Switzerland in English, French, Russian and Spanish; 269 + xxviii pp; 129 figures, 28 tables; price Sw fr. 33; soft back; ISBN 92–63–11332–2. Order from WMO, Geneva or, for US and Canadian residents, from the American Meteorological Society, 45 Beacon Street, Boston, Mass. 02108.

The second edition of this report contains important improvements on the previous edition (1973). These are mainly in the chapter on generalised Probable Maximum Precipitation (PMP) estimates and the addition of a much-needed chapter on PMP estimates for tropical regions, those within about 30 degrees of the equator. The revision was done mainly by Mr. J.F. Miller (USA).

In the first edition it is stated (p. 4):

"The meteorological procedures discussed are more suitable to middle latitudes than to the tropics. in the tropics the heaviest rainfalls are associated with very high atmospheric moisture, which prevails most of the time during the rainy season. Hence, there is neither theoretical nor empirical reason to relate rainfall potential to the minor fluctuations in humidity that occur. It is for this reason that the meteorological procedures presented are considered to be generally inapplicable to the derivation of PMP estimates for the tropics."

In the reviewer's experience this warning has frequently been disregarded in studies for tropical areas. Thus, the term PMP has been mis-applied to many tropical storm estimates and dam spillways have been built to pass different, and usually smaller, floods than those intended. Hopefully, the new edition will help to redress this serious situation.

How have the authors tackled the problem of PMP estimation for tropical regions? Many of the basic steps to derive PMP values in temperate latitudes are considered applicable to tropical regions, although modifications are needed and unusual difficulties arise. Because fewer PMP studies have been made for the tropics the procedures are less well-developed.

A basic requirement is for a thorough understanding of the meteorology of major storms throughout the region under study, as in all PMP analyses. Storm transposition becomes increasingly important where data are sparse and advances in the understanding of storm dynamics are extending the areas over which storms may be transposed; this includes inter-continental transpositions. Sequential and spatial maximisation, particularly in PMP studies for large areas, become more important in tropical areas. The former involves the development of hypothetical, critical rainfall sequences with minimum time intervals btween individual events; the latter the re-positioning or geographical transposition of storm events. Very experienced meteorological judgment is obviously essential in such studies.

Three examples of tropical PMP studies are described. These are for the Hawaiian Islands, the Lower Mekong River basin in SE Asia and for most of Peninsular India. They give a good insight into the complexities involved and the magnitudes of the storms derived (Figure 6.2.4). the final caution is that "much is still to be learned about developing PMP estimates in tropical regions"; advice which all those associated with such studies and with dam spillway designs should heed.

One feature which stands out clearly is that PMP studies are complex and require very experienced judgments by highly qualified staff. The time required and the costs of such studies is large. Therefore it is essential that as much background work as possible leading to generalised regional and national information is undertaken before specific project studies. Only in this way can reliable PMP estimates be derived for most projects, with their usually tight programmes and limited resources.

The first edition of this important report has been used extensively. The new edition should be available to all meteorologists, hydrologists, engineers and others involved in PMP studies and the flood aspects of dam safety.

M. Mansell-Moullin

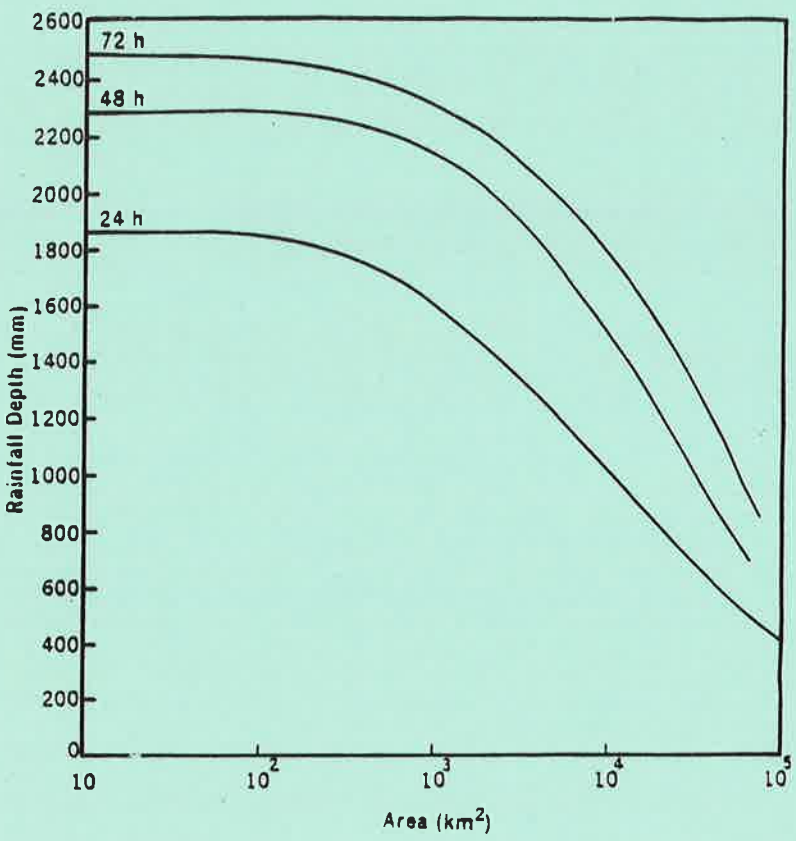


Figure 6.2.4 Normalized PMP depth-area-duration curves for India [Rakhecha and Kennedy, 1985].
Note: "Normalised PMP values are applicable to flat land at sea level near the coast.

CONJUNCTIVE WATER USE

Understanding and managing surface water–groundwater interactions.

This publication is edited by S.M. Gorelick of the US Geological Survey and contains the papers presented at a symposium held during the 2nd Scientific Assembly of the International Association of Hydrological Sciences at Budapest, Hungary, July 1986. The proceedings are henceforth to be known as IAHS Publication No. 156 and are available for "an arm and a leg" from the IAHS Editorial Office at the Institute of Hydrology.

This volume contains some 50 papers and includes four keynote addresses on such varied topics as water quantity aspects, water quality aspects, the groundwater-atmospheric interface and last but not least on how to be friends with your environment by managing matters in a conjunctive manner. The most notable impression gained from a tentative dip into the underlying material that makes up this symposium topic is that the groundwater hydrologist would appear to be blessed with a confusing variety of differential equations with which to model the almost unmeasurable. A particularly striking feature being the great interest shown by many authors in solving special cases that do not necessarily occur in nature but nevertheless apparently provide great insight into the various unmeasurable processes alluded to previously. Statisticians have also now discoved that groundwater and surface water interact and we may be at the dawn of a great new age in describing these unmeasurable processes with various special cases of the laws of probability. This may not be a revolution as fundamental as the "stochastic" versus "deterministic" days of the 1970s when you had to choose a side, but may cause some ripples in the cosy world of the traditional groundwater modeller.

The volume of papers provides a clear, cogent update to anyone's knowledge of this area and for that reason it comes well recommended from a symposium attendee who skillfully managed to miss most of the papers being presented by the various

authors. The most exciting aspect of the symposium was of course the necessity of going to Budapest in order to derive maximum benefit from the ambience of that magical and atmospheric city. The magnifient wines of the region whose consumption greatly benefited from the interaction between surface and groundwater hydrologists proved an irresistible attraction to many delegates as the temperature hovered around 80°F during the period of the symposium. Unfortunately the resulting proceeding cannot quite live up to the overall experience obtained from attendance at such an international jamboree of higher learning but do provide a relatively painless way of becoming an instant expert on the subject of conjunctive use.

Ian Cluckie

Obituary

Charles V. Theis 1900–1987

Ask anyone who has even a limited knowledge of groundwater to remember any important name and they are almost certain to mention the name 'Theis'. It was in 1935 that C.V. Theis published his most important paper on the time-variant equation for radial flow to a pumped well; his approach continues to be the foundation of well hydraulics and from this basis more advanced and involved equations have been derived.

Theis obtained a bachelor's degree in Civil Engineering, a PhD in geology and in 1929 he joined the United Sates Geological Survey. Prior to the publication of his paper, aquifer studies were based on steady-state theory. By using the concept of a radius of influence it was possible to make estimates of the transmissivity of an aquifer. Theis realised that this form of analysis ignored the time-variant responses during the pumping and recovery phases. The 'clue' which prompted Theis to develop his theory was the analogous heat conduction problem. A friend from the University of Cincinnati adapted the heat conduction equation to represent radial groundwater flow and Theis then proceeded to apply the resultant equation to the head distribution in the vicinity of pumped wells.

In his paper Theis did not use the double log plot that is in common use today; instead he took results for observation wells at the same time but at differing distances from the pumped well to estimate the 'transmissibility'. However for the interpretation of the recovery results he did use the log-arithmetic plot with the ratio of the total time to the time of the recovery phase; therefore this is correctly called the Theis recovery method.

Theis's paper in 1935 was a significant step forward. In part it was a step in the dark. A reading of his paper indicates that he did not understand the full significance of his contribution. The 'Theis' equation is not derived from the governing differential equation for groundwater flow; instead it is deduced by comparison with the heat conduction problem. Nevertheless, he was fully aware of the idealisations inherent in the derivation. It was because of these idealisations that many of his colleagues initially treated his work with scepticism; time has shown that his contribution was a breakthrough. However, in later years Theis was constantly urging workers not to use the equation in situations where the assumptions were clearly violated.

Theis remained with the USGS for most of his life. He served as a district geologist in New Mexico and later became co-ordinator for waste disposal to the Atomic Energy Commission. In addition he held part-time appointments at Universities. It is encouraging to realise that it was a man committed to field work who made one of the most important contributions in the study of groundwater flow.

Ken Rushton

NEWS FROM MEMBERS

MEMBERS ON THE MOVE

David Rees writes to tell us that he has left his present position as a Research Fellow in the Department of Civil Engineering, Birmingham University, for a post as Assistant Engineer in the Supply Department of the East Worcestershire Waterworks Company. David is based in the Company's head office, 46 New Road, Bromsgrove, B60 2JT (Tel: 0527–75151).

John Stowell has recently left Binnie and Partners, and is now working as a freelance consultant in hydrology and water resources development.

Ian Menzies has moved from the Rivers Division of Thames Water to join the Corporate Development Group.

Two other eminent members on the move are **Jim McCulloch** and **John Rodda**, Director and an Assistant Director at IH, respectively. Jim McCulloch is moving on to higher things at NERC headquarters (precise details not yet known – watch this space). John Rodda is to take over the post of Director, Hydrology and Water Resources, in WMO, recently vacated by Jerry Nemec. Jim starts at Swindon on 1st December, John in Geneva in mid-January. Congratulations to both of them. (Spare a thought for IH with its top management decimated overnight!)

THE GREAT WIND

The Met. Office is preparing a hand-out for schools on the whys and wherefores of the Great Wind of 16 October. In the meantime, preliminary comments from Bracknell are that the 86-knot gusts recorded at Gatwick have a 300-year return period, while the 81-knot gusts at Heathrow fall in the 500-year category.

Devastingly spectacular but not perhaps as hydrologically significant as some of the other record-breaking meteorological phenomena of recent years – unless anyone wants to speculate on long-term effects of changed catchment characteristics?

DATA LOGGERS

IH are currently going through the same exercise that many other groups with down the same path already trodden by many other groups within the Society, namely a review of data loggers. IH has long been associated with the Microdata logger (having played a large part in its development) but it is now time to think about a replacement. The main application is with the automatic weather stations, not only those operated directly by the Institute in its own research programmes but also in the NERC AWS pool which go out on hire to universities and water authorities.

SMALL CATCHMENT DESIGN FLOWS

At the National Symposium in Hull, BHS members views were canvassed regarding the need for an improved method of design flood estimation specifically for small catchments (i.e. $< 5\,km^2$). Any members not present at the Symposium who are interested in the topic, and would be willing to complete a short questionnaire summarising their experiences and views on any deficiencies of current methods, should contact **Mark Robinson** at the Institute of Hydrology (Tel: 0491–38800).

SOUTH AFRICAN WATER RESOURCES

Dr Denis Hughes of Rhodes University, Grahamstown, has drawn our attention to the comprehensive hydrological sciences symposium held recently, published papers from which, on a wide range of topics relevent to South African water resources are available in a two-volume proceedings. These cost £25.00 to include packaging and surface mail to the UK, available from him at the above address (cheques or international money orders should be made payable to Rhodes University).

REDUCED SUBSCRIPTIONS

It has been agreed within the Main Committee that members fully retired from work are eligible for a 50% reduction in BHS membership subscription, i.e. £6.00 a year at the present time.

PRODUCT NEWS

A new family of hydrometric logging and processing systems for microcomputers is being developed by Hydro-Logic Limited of Marden, Herefordshire. Based on a new range of solid-state data loggers called "Newlog" manufactured by Technolog Limited of Cromford, Derbyshire, the packages offer a complete solution for those organisations monitoring rainfall, water-level and flow measuring stations.

The "Newlog" recorder is powered for life in a compact rugged polycarbonate case sealed to IP67 standard, measuring 190 × 75 × 75 mm and weighs less than 600 gms. A variety of sensor inputs are already available including frequency and pulsed inputs. The rainfall logging system is available now, with a water-level logging system utilising an absolute shaft-encoder available in the near future.

Hydro-Logic's software operating on a Husky Hunter and on the IBM PC range of micros configures the logger for rainfall recording when attached to virtually any tipping-bucket raingauge. The rainfall logger has a potential capacity of nearly 14,000 tip "events" for a one month operating period with a recording resolution of ten seconds. The logger can be disconnected froim the raingauge and brought back to the office for processing on an IBM PC compatible microcomputer, but the recommended method of operation is to use a field portable Husky Hunter microcomputer, specially programmed to facilitate control of the logger and to retrieve stored readings whilst the unit remains in the field attached to the raingauge.

The Husky Hunter based *Rainlog* software includes the following features:

- Menu-driven user-friendly software with full error trapping routines.
- User control of logger operation via the Hunter's keypad.
- Inspection of rainfall record on-site using the Hunter's LCD screen as either daily totals or hyetograph plots.
- Output of retrieved log-files to another computer.
- Optional operation as a "Universal" retrieval and analysis system when integrated with similar programs for other recorders such as the Technolog Tinylog, Grant Squirrel, Warren Jones Ranger and Space Age loggers.

Two alternative software packages are available for the IBM PC or AT range of microcomputers, for processing data retrieved direct from the logger or via the Husky Hunter retrieval system.

The standard system, *Rainlog*, offers similar facilities as above with additional features including:

- output of a formatted tabular listing of hourly and daily rainfall data to a printer.
- A graphics screen-dump of a hyetograph can be produced on a printer.
- Reformatting of data into a disk-file which can be accessed by spreadsheet packages such as *Lotus 123*, *Supercalc* or *Smart*.

Rainark is a more advanced system for the IBM PC offering similar features as above, but also facilitates the creation and maintenance of a continuous archive file record of rainfall from a network of tipping-bucket raingauges.

Additional features include:

- Merging of data-log files together to form a single archive file record.
- Display of hyetographs with great flexibility in changing period and scale.
- Graphical editing facility.
- Output to a colour graphics plotter if required.
- Production of monthly and annual summary report printouts.

Special offer to BHS members: A *free* demonstration version of the *Rainlog* system is available on an IBM PC format floppy disk from Hydro-Logic Limited.

For further details of the above packages, contact **Rod Hawnt** or **Alec Willis** at Hydro-Logic Limited – telephone 0568–84439.

Digitised rainfall records from the Met. Office

As a result of the Flood Studies Report published in the mid-1970s there was renewed interest in the variation in time of rainfall, particularly for modelling the response to rainfall of flows in drains and rivers. As a consequence the then Rainfall Branch of the Meteorological Office at Bracknell commenced a programme of digitisation of Tilting Siphon Recorder (TSR) charts. The system used involved scanning electronically a photograph of each chart which had previously been treated to show a uniform and continuous trace. The digitised dta are the accumulated rainfalls at each minute during non-dry days.

The processing was terminated as it was expensive in both computer and staff time but not before a considerable amount of digitisation had been carried out. With the changes of the computers and computing systems at Bracknell since then, the data had become largely unusable even to our own staff! Recently, however, the Advisory Services Branch has needed to use these data and a successful effort has been made to make them more easily accessible and to provide up-to-date documentation.

The data are from two complementary groups of TSR stations. The first group is a relatively dense set of about 100 gauges run by local authorities in the Greater London area with record lengths ranging from 1 to about 40 years. The second is a more wide-spread group of 15 Meteorological Office gauges within an area bounded by St. Mawgan, Cornwall, to the south-west, Gatwick to the south-east, Finningley, near Doncaster to the north-east and Shawbury, to the north-west. The records from this group range from about 20 to 30 years. Apart from periods which are indicated, of missing observations, the data can reproduce the original traces with negligible loss of accuracy. They are available on a variety of computer media.

Further information about this dataset can be obtained by contacting: Enquiries Section, Advisory Services Branch (Met 0 3), Room 227, Meteorological Office HQ, London Road, Bracknell, Berkshire RG12 2SZ. Telephone: Bracknell 420242, extension 2233.

B. May

HYDROLOGICAL PROCESSES

Members of the British Hydrological Society wishing to purchase the journal *Hydrological Processes* published by John Wiley & Sons can do so at a 50% discount, the price to members being £32.50 as against the usual price of £65.00.

When applying for the Journal please indicate on your letter that you are a member of the Society and wish to take advantage of the special discount.

BRITISH HYDROLOGICAL SOCIETY

Report of the Hon. Secretary

for the year ending 30th September 1987

The Annual General Meeting to be held on 7th December 1987 will be the first at which I have had the pleasure of reporting to the Society on the business of the preceding year. My job as Honorary Secretary has been greatly expedited by the clear framework for Society business, and meticulous documentation of the same, established by my predecessor, **Professor M.J. Hall**. It is therefore a pleasure to report firstly on several issues which were discussed originally by the Main Committee in the time when Mike Hall was in post and have now come to a satisfactory conclusion. It has been learned recently, after lengthy discussions with the Charity Commissioners and following changes to the Society Statutes which were approved by the Membership in March, that charitable status has been granted to the Society. The past year has also seen the publication of *Weather Radar and Flood Forecasting*, (the Proceedings of the Lancaster Meeting, September, 1985) and the *British Directory of Hydrology*, a project first mooted in 1984. Although gestation of the latter has been protracted, the Main Committee consideres the end-product to represent an attractive handbook which should have appeal and usefulness to both the Membership and beyond.

A new *Register of BHS Members* has also been produced this year, and the intention is to update this Membership Directory at two-yearly intervals. Publication matters have been to the fore in the quarterly meetings of the Main Committee. The Publications Sub-Committee in a policy report stressed the importance of BHS publishing activities and recommended that some expansion was appropriate, especially in the form of an Occasional Paper Series. A standing Sub-Committee of two Main Committee members, **Mr. T.E. Evans** and **Mr. R.J. Sargent**, is currently investigating the form which such a series might take.

Mounting of scientific meetings continues to be a major activity of the Society. The Meetings Sub-Committee has reviewed the organization of National Meetings and a provisional programme of these events extending until the end of 1989 has been developed. Guidelines have been established for future planning of scientific meetings, whereby the Society will aim to hold a minimum of four National Meetings per year with these usually being scheduled for December (following the AGM), March, May and September. It is projected that the Society's National Symposium will take place as the September National Meeting in alternate years. A maximum of two additional National Meetings will be arranged per year when appropriate, and future planning will continue to consider the balance between meetings mounted solely by BHS and those organized jointly with other bodies, the selection of topics with wide appeal within the Membership, the possibility of field visits and the distribution of venues. In the last context, it is pleasing to note that the forthcoming AGM will be the second to be held outside of London.

In the year under review, the Society has staged six National Meetings and all were well supported. Two of the National Meetings were held in London on the topics of "Microcomputers in Hydrology" and "Social and Environmental Aspects of Water Resources Projects". The former introduced a novel and successful meeting format of practical demonstrations interspersed with lecturettes, while synopses of the papers presented at the latter, which was a joint meeting with the Royal Geographical Society, are being published in the journal *Regulated Rivers*. National Meetings were also held jointly with the British Soil Water Physics Group at Rothampstead on the topic "Hydrology is Mostly Soil Physics", with the British Geomorphological Research Group and British Sedimentological Research Group at Lancaster on the topic of "Hydrology, Sedimentology and Geomorphological Implications of Floods", and with the Royal Society of Edinburgh and Scottish Hydrological Group at Edinburgh on the topic of "Hydrology in Scotland". The latter meeting was particularly successful and will generate a special volume of the *Proceedings of the Royal Society of Edinburgh*.

A milestone in the history of the National Meetings organized by the Society was reached in September when BHS mounted its First National Hydrology Symposium at Hull. Modelled on National Hydrology Symposia in Australia, this two-day meeting was primarily concerned with "hydrology in practice" and contained separate sessions on "Flood Hydrology", "Environmental Hydrology" and "Application of New Technology" as well as parallel sessions on "Water Resources" and "WASSP in Practice". Although events at Hull are to be reported fully in a special supplement to *Circulation*, it is worthy of note in this report that the Society was honoured to have **Mr. David Jeffrey** of Yorkshire Water and **Professor Russell Mein** of Monash University participating in the Opening Ceremony and Introductory Session of the Symposium. The Society owes a debt of gratitude to many individuals who helped to make the Hull Symposium a success, but particular thanks are extended to **Professor Roy Ward** of the University of Hull, who acted as local organizer, and to **Celia Kirby** and **Mike Lowing** of the Institute of Hydrology, who not only masterminded many of the arrangements but also ensured that the *Proceedings of the First National Hydrology Symposium* were pre-published as a highly professional 300 plus page volume.

The Society continues to provide scientific meetings through the Regional Sections. The Southern Section and Midlands Section have held four and two meetings respectively during the last twelve months, and the past year has seen the inaugural meeting of the South-West Section. The latter Section also staged a Spring field meeting.

In its work since the last AGM, the Main Committee has endeavoured to heighten the national and international profile of the Society, and also to increase the flow of information to the Membership on several aspects of hydrology at home and overseas. Under the energetic leadership of our President, BHS has discussed and responded to recent Government proposals concerning the privatization of the Water Industry and the establishment of a "National Rivers Authority". The activities of the Society have been drawn to the attention of the UK Committee for the European Year of the Environment (EYE), and there have been increased efforts to establish contacts with overseas hydrological societies. To date, links which involve exchange of publications and information on membership and events have been set up with the Association of Hydrologists of India, the Indian Association of Hydrologists, the New Zealand Hydrological Society and the Yugoslav Association for Hydrology. Similar arrangements are being made with the Brazilian Hydrology and Water Resources Association and the South African National Committee for the IAHS (SANCIAHS), and it is intended over time to establish further contacts with as many countries as possible. Information on current British research in hydrology is being sought through a new series of articles in the Newsletter, and a parallel series of reports in *Circulation*, explaining the activities of overseas organizations engaged in hydrological work, has been initiated recently. A regular article providing news from the Water Industry is projected for *Circulation* in the near future.

In this my first report to the AGM, I would like to acknowledge the help and forbearance of my colleagues on the Main Committee as I have learned procedures and become acquainted with the filing system. On behalf of the Officers and Main Committee, I also express our gratitude to all those individual members who have assisted with Society activities and particularly to local organizers, speakers and reporters who have continued to maintain the high standard of the Society's meetings at National and Regional level.

B.W. Webb

TREASURER'S REPORT 1986/87

The financial year to 30 September 1987 has been one of particularly heavy expenditure (and hence the need last year to increase subscriptions) but the Income and Expenditure account has finished the year with an income of £6,543 yielding a surplus of £671 to augment our 1986 accumulated balance of £1,968.

Routine costs of photocopying, printing and postage at £2,968 showed an increase of 9% compared to £2,725 in 1985/86, partly due to larger Circulation but meetings expenses were reduced by £186 (from £431 in 1985/86). The ICE administration fee has remained unchanged at £2 per head.

This year we have produced both a Membership List and the BHS Directory. Advertising revenue made a significant contribution to production costs, but the net expenditure was a substantial £1,216.

The major event of the year was the BHS Hull Symposium, which was clearly a major success. However, the turnover for this meeting approached twice our annual subscription income, so that final accounts for this event has been awaited with some concern! In the event, a loss of £433 was recorded, however, this includes a print-run of Proceedings which is expected to yield significant post-symposium sales, to offset this deficit.

The prospect for the 1987/88 financial year

is of reduced expenditure, and subscriptions have been held at £12. However, with major events costing in excess of £10,000 it is necessary to continue to develop the financial base of the Society, and hopefully a surplus will be generated to provide a more secure base for future activities.

Finally, this is my last report to the Society as Treasurer, and I would like to acknowledge the support of the President and Committee of BHS, and particularly of Norman Tyler and the ICE staff. My best wishes go to Frank Farquharson on picking up the reins.

Howard Wheater

FORTHCOMING EVENTS

MEETINGS

IAHS THIRD SCIENTIFIC ASSEMBLY
Baltimore, Maryland, USA
10–19 May 1989

The programme will consist of eight Commission/Committee sponsored sympsosia covering essntially all phases of the hydrological cycle.

- Atmosphere Deposition
- Systems Analysis for Water Resource Management – Closing the Gap Between Theory and Practice
- Surface Water Modelling – New Directions for Hydrologic Predition
- Regional Characterization of Water Quality
- Stochastic Processes and Time Series Analysis in Glaciology
- Sediment and the Environment
- Groundwater Contamination
- Remote Sensing and Large-Scale Global Processes

In addition there will be five concurrent PC computer workshops providing hands-on opportunity for author demonstrations of new programs:

- Methods for precipitation modelling
- PC methods in water resource systems analysis
- PC methods for image processing and geographic information systems
- PC methods for flood frequency analysis
- Methods for groundwater quantity and quality analysis and modelling.

Further information from: Mr. Ivan Johnson, Chairman, TSA Organizing Committee, A. Ivan Johnson Ince, 7474 Upham Court, Arvada, Colorado 80003, USA

NATO ADVANCED STUDY INSTITUTE "RECENT ADVANCES IN THE MODELLING OF HYDROLOGICAL SYSTEMS"
10–23 July 1988
Sintra, Portugal

This NATO ASI will provide a systematic review of the current state-of-the-art in hydrological system modelling, current modelling issues and technological trends, and potential future directions. Fifteen leading US and European research workers will contribute to the ASI through lectures and computer workshops.

Funds are available to contribute towards the travel and subsistence expenses of graduate students and other participants. For further information on the ASI, or to apply for funds to subsidise your participation please contact the European Co-Director: Prof. P. Enda O'Connell, Department of Civil Engineering, University of Newcastle-upon-Tyne, Claremont Road, Newcastle-upon-Tyne, NE1 7RU, UK. Telephone: 091–2328511 extension 2405.

Provisional Programme of BHS National Meetings for 1988

Month	Topic	Venue
March	Ground Water Modelling	Leeds
May	Problems with Water Acidification (with Welsh Hydrological Group)	Llyn Brianne (Field Visit)
September	Urban Hydrology	Birmingham
October.	Hydrological Aspects of Landfill (with Scottish Hydrological Group)	Glasgow
December	Overseas Hydrology (with AGM)	London

Full details confirming dates, venues and programmes for these meetings will be circulated to members in due course either through *Circulation* or via "flyer".

BHS NATIONAL MEETINGS

The Society is planning to hold a National Meeting on Hydrology Overseas in December 1988, immediately following the Annual General Meeting. This will be a good opportunity for those members who are often overseas, and so miss many of the Society's meetings, to describe their experiences or research. Accounts of successes and problems will be equally interesting.

If any member would like to contribute to the meeting, would they please write to the organiser, Mike Mansell-Moullin (c/o the Society or at his home address).

DIARY

2nd December 1987
Welsh Hydrological Group/BHS South-West Section.
"The ecological effects of resource development" – Dr. Stephanie Tyler (RSPB).
Engineering Department, Bristol University. 5.30 for 6.00 p.m.

4th December 1987
Scottish Hydrological Group.
"Nature conservation and hydrology" – D.M. Bayne (Nature Conservancy Council).
No. 2 Lecture Theatre, McCance Building, Strathclyde University. 6.00 for 6.30 p.m.

7th December 1987
BHS Annual General Meeting.
11.30 a.m. Aston University followed by BHS National Meeting.
"Remote Sensing Applications for Water Management".

15th January 1988
Scottish Hydrological Group.
"Recent contrasting summers in Scotland – a historical perspective" – Miss M.G. Roy (Meteorological Office).
Wellcome Room, Royal Society of Edinburgh, 22–24 George Street, Edinburgh. 6.00 for 6.30 p.m.

25th February 1988
Pennines Hydrological Group/Northern Counties Association of ICE.
"The economic uses of water resources in the North West" – J.M. Knowles and Dr. S. Walker (NWWA).
Carlisle Civic Centre. 6.00 p.m.

17th March 1988
Welsh Hydrological Group.
"The Cardiff Bay barrage" – speaker from Wallace Evans & Partners.
University College, Cardiff. 5.30 for 6.00 p.m.

20th April 1988
BHS Midlands Section Spring Meeting.
"Agriculture and water quality in the Midlands" – Andrew Skinner (STWA), Roger Unwin (MAFF) and André Carler (Soil Survey).
Coventry Polytechnic. 2.00 p.m.

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