THE NEWSLETTER OF THE BRITISH HYDROLOGICAL SOCIETY

Circulation

No. 55 August 1997

Moray floods 1st-3rd July 1997

The lowlands bordering the southern shore of the Moray Firth eastwards from Inverness experienced severe floods during the period 1st-3rd July 1997. More than 1200 people were evacuated from over 400 flooded homes and agricultural land was extensively inundated. Disruption to business and transport was widespread, with main road and rail links cut for extended periods. The great cost in terms of human suffering was mirrored by substantial financial losses, with one company alone suffering £25 million damages.

The weather pattern behind the events was generated by a slow moving depression in the North Sea together with an occluded front, which led to persistent driving rain and north-easterly winds hitting the low foothills and coastal plains of the southern Moray Firth. SEPA raingauges showed that a broad band of country from Inverness eastwards to Banff experienced from 80 to 100 mm over 48 hours, with the heaviest rain occurring in the 24 hours from 2200 on Monday 30th June.

Some notable accumulations were recorded including a 2-day total of 150.2 mm at Relugas, some 10 km south of Forres. Amounts fell away dramatically inland and this gradient is well illustrated by 24-hour totals of 104 mm near the mouth of the Spey compared to only 8 mm for the same period in the upper catchment. Figure 1 shows the hyetograph for hourly rainfall at Lochindorb, 22 km south of Forres, combined with the River Divie hydrograph for Dunphail. Initial analysis of the SEPA rainfall data based on Meteorological Office return periods would suggest 24-hour totals at Lochindorb were slightly in excess of a 50-year event and at Relugas approximately a 200-year event. Such figures should clearly be treated with great caution given the provisional nature of the data together with the possibility of more extreme hydrological events associated with the climatic change scenario. It may well be that the latter will require reassessment of established return period analysis.

Runoff from the catchments in the area was not unexpectedly at its most intense in the lower sections of the main river systems together with the smaller coastal watercourses draining to the southern shore of the Moray Firth. The Rivers Nairn, Divie, Lossie and Isla all exceeded previous levels in records extending for 18, 14, 34 and 28

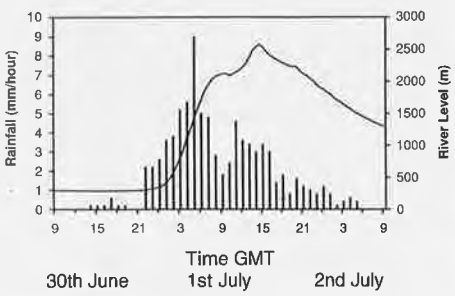


Figure 1 *Rainfall at Lochindorb (bars) with River Divie level at Dunphail (line)*



Figure 2 *Boats being used, not entirely for emergency purposes, as Forres residents take belongings away from their flooded homes*

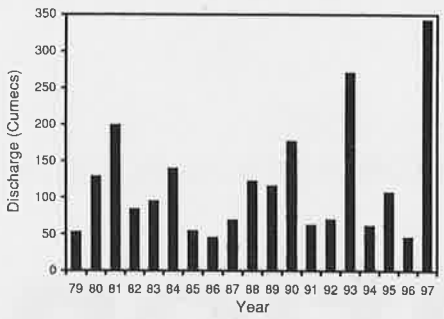


Figure 3 *Variability in annual maximum discharge for the River Nairn at Firhall*





Figure 4 *(above) Flooded properties in the flood plain at Elgin, at the height of the flooding on Wednesday July 2nd*

Figure 5 *(left) Younger residents getting used to it all in Forres* (all photos by A R Black)

years respectively. All larger rivers peaked in their lower reaches in the late afternoon and evening of 1st July, except the Lossie, which did not peak until 1030 on the 2nd. This difference results from the relatively steep gradient of rivers such as the Findhorn and Spey, enabling rapid transmission of flood peaks compared to rivers with lesser gradients such as the Lossie. In an historic context, most of these rivers have recorded their peak floods during the summer, though more often in August or September, and typically with similar meteorological conditions. The highest recorded 2400 cumec Findhorn flood in August 1970 was not exceeded on this occasion, but is likely to have been considerably exceeded by the August 1829 event, which forms something of a historic benchmark. The present floods were particularly noteworthy for their generation in the lower catchments alone.

Assessment of the flood peaks carried out so far would suggest a 25- to 30-year return period event on the Nairn and Divie, but possibly a 55-year event on the Lossie. Return periods for some of the smaller watercourses may well have been more exceptional again. The time series histogram of annual peaks for the River Nairn at Firhall (Figure 3) illustrates the trend towards greater variability. A health warning similar to that attached to the rainfall figures should also be applied to these return periods. It should also be noted that the peak flows used in the analysis are based on extended extrapolation of the stage/discharge equations. Thus for example the highest check gauging of 136 cumec on the Nairn (catchment area 313 km^2) is well below the suggested 342 cumec peak recorded on 1st July. The problem of measuring extreme floods in the open channel sections routinely used in SEPA North gauging stations was vividly demonstrated by the loss of a current meter during gauging on the peak of the Divie flood. The rivers carry a high debris load during large floods, and a semi-submerged tree trunk travelling at several metres per second leaves little chance of raising the meter clear of the water in time!

It is interesting to note that this latest newsworthy flood has again occurred in Scotland, following the noteworthy Tayside event of January 1993 and the Strathclyde floods of December 1994. Indeed, the increase in variability in the Nairn annual maximum series is a feature that is found in a great number of Scottish rivers. These observations appear to form part of a recent steepening of the general hydrological gradient between north-west and south-east Britain, in which most of the shift has been due to increased rainfall in the winter half-year, and associated with increased westerliness in weather patterns. It is interesting, however, that this most recent flood has occurred in the summer half-year, under cyclonic conditions, and less than two years after a similar (though less extreme) event in this area.

SEPA is responsible for provision of flood warning schemes in Scotland and these are mainly operated in conjunction with the police authorities. Much essential information was provided to police and local authorities throughout the events following the initial automatic generation of alarms. The latter were issued for the Rivers Nairn, Lossie, Findhorn and Spey, but a particularly noteworthy feature was the absence of upper catchment alarms from the Findhorn and Spey because of the genesis of the floods in the lower parts of the main river systems. The extent of damage occasioned by inundation will undoubtedly raise many questions about the extension of existing flood warning schemes and the provision of new ones, especially in some of the smaller catchments. SEPA is likely to consider any approaches sympathetically, in the light of technical feasibility and available resources.

One of the new duties that fell to SEPA under the Environment Act 1995 was flood risk assessment, and events such as the Moray floods highlight the urgent need to gather all available information on the extent and depth of inundation to permit effective provision of advice to planning authorities when determining future applications for development.

Richard C Brown, Head of Hydrology, North Region, SEPA
Andrew R Black, Geography Department, University of Dundee

Sixth Symposium, Salford, September 1997

A final reminder that the **6th BHS National Hydrology Symposium** will be hosted by the University of Salford from *15th-18th September*. Salford University is on a pleasant campus only a mile and a half from the city centre of Manchester, one of Britain's most vibrant and cosmopolitan cities.

The Symposium will feature presentation of over 35 technical papers on a range of hydrological topics, including water resource management, water quality, hydrological modelling, remote sensing and climate change. The programme will also incorporate a technical exhibition, poster presentations and the BHS Annual General Meeting (at ***10.30*** on *Tuesday 16th September*). There will also be a field visit to the Salford Quays and the Irwell Flood Defence project.

The Symposium will feature a number of keynote presentations, and **Professor Volkard Wetzel**, Director of the Federal Institute of Hydrology in Koblenz, has been invited to deliver the prestigious Penman lecture (immediately after the AGM), following in the footsteps of the memorable lecture by **Professor Jim Dooge** at the Fifth Symposium at Heriot-Watt University in 1995. The Federal Institute is at the heart of much European macro-scale hydrology, and it is hoped that Professor Wetzel will speak on the Rhine flood history and aspects of the Oder/Polish/Upper Danube floods now under way (and said in some reports to be the worst since the Middle Ages in at least one locality).

As always, an exciting social programme has been organised. There will be a Civic Reception in the Salford Art Gallery (fans of L S Lowry take note), a Reception in the impressive Manchester Town Hall and a Symposium Dinner in Tatton Hall (Tatton Park).

Please note that the BHS Committee has decided to make discretionary funds available to help students and young hydrologists attend the Salford Symposium. Please contact Kevin Tilford for further information or send him by fax/email (see below) a paragraph stating your case for support as soon as possible.

Last, but certainly not least, the organisers would like to thank the following organisations for their generous support of the Symposium: the Institute of Hydrology, United Utilities plc (North West Water), Yorkshire Water plc, The Mersey Basin Campaign and NISC Information Services Co. Ltd.

Further information about the Salford Symposium may be found on the BHS world-wide web pages (http://www.salford.ac.uk/civils/BHS) and in the Final Announcement enclosed with this issue of *Circulation*. Please direct all enquiries to Dr Kevin Tilford (*email bhs97@civils.salford.ac.uk, tel. 0161 295 3458, fax. 0161 295 5060).*

The UK becomes a full member of UNESCO again

IH reception marks UK re-entry into UNESCO

The UK IHP Committee took the opportunity of a visit by *Dr Andras Szöllösi-Nagy* of UNESCO to the Institute of Hydrology to hold a formal presentation to mark the UK's return to the UNESCO fold on 1st July 1997. Dr Szöllösi-Nagy was at IH attending the BHS Exeter Symposium organising committee.

Brief speeches were given by **Professor Jim Wallace** on behalf of the host Institute, **Professor Des Walling** on behalf of the university sector with connections with the IHP, **Professor Brian Wilkinson** (Director of CEH), who expressed the pleasure of WMO staff at Britain's renewed interest in international hydrology, **Dr John Rodda** as President of IAHS and **Frank Law** as Chairman of the UK IHP Committee.

This was **Dr Szöllösi-Nagy**'s formal response:

"Ladies & Gentlemen, It was not very far away from here, in the City of Cardiff — not so long ago either, perhaps 3 or 4 years — when I made the most successful prediction of my life in my keynote speech at the biennial symposium of the British Hydrological Society, namely that the United Kingdom would return to UNESCO. True, I did not specify when this would happen. Nevertheless, thanks to everybody involved in this process, it has happened. As from *Tuesday 1st July 1997*, the United Kingdom is once again a full member of UNESCO. So, here I am today, not just a simple visitor as I was in the past, but rather as your humble servant with the desire to revitalise the participation of the British hydrological community in UNESCO's International Hydrological Programme (IHP). Not that the United Kingdom's participation ceased with its withdrawal from UNESCO — far from it. Ten years ago, in this very place, one of the most successful IHP activities, FRIEND, was launched. I sincerely believe, however, that British participation in IHP can be expanded and enhanced. You have a tremendous amount of knowledge which you can certainly share with others, particularly with our colleagues in the developing world.

"Because of age (too young rather than too old), many of you may not be familiar with the role Britain played in creating UNESCO more than 50 years ago. It was in Westminster, just a few yards from the Houses of Parliament, on *16th November 1945*, that UNESCO's constitution was adopted. **Sir Julian Huxley**, a British scientist, was the first Director General of UNESCO, and he was responsible for mobilising the UK scientific community for the noble cause. Some of you here today were present at the launching of the International Hydrological Decade — the first organised global research effort in hydrology. In fact, I believe it is not an overstatement to say that it is the Decade which made hydrology a science.

"As you know, the Decade was followed by the open-ended International Hydrological Programme, which is in its fifth phase of six-year cycles (I know the algebra does not work out, but IHP-I and IHP-II were of only two years' duration each). By launching IHP in 1975, as a fully-fledged intergovernmental programme, UNESCO's member states clearly indicated the importance they attach to freshwater research issues. And this was well before environment became the order of the day, well before UNCED and well before it was generally recognised that water was going to be one of the — if not **the** — critical issues of the 21st century. I believe that IHP, the only global hydrological science programme within the United Nations system, has largely contributed to this recognition.

"IHP-V activities are extremely numerous and British scientists have played an active role in a great many of them, such as the FRIEND programme, erosion and sedimentation related projects, the Humid Tropics programme, the wadi hydrology programme and climate-related studies, to name but a few. (Somehow we were always able to find international "cover" organisations under which the Brits could sail into IHP. It is sure that without you the IHP would have been severely handicapped).

"Ladies and Gentlemen, Many people asked me this morning what IHP expects from British Hydrology. Well, there is a long wish list which I could present, but I will focus on a few major points.

"First of all, I think it is desirable to re-establish and/or-reorganise the UK IHP National Committee. As you know, many changes in the management of IHP have occurred over the past years so perhaps rethinking the role and functioning of the National Committee would be in order. Questions could be put such as: 'Could the National Committee function as the highest level hydrological scientific advisor to the British Government?', or 'How could the participation of the whole spectrum of hydrology players be ensured?' or again, 'How could all the hydrology and water resources professors of the various universities play an important role?' (after all IHP has another facet: the education of hydrologists at all levels.), or 'How could the professional NGOs be involved?'

"All in all it would be a very welcome development if the IHP National Committee could be transformed into an active think-tank and serious government advisor in issues of hydrology and water resources — both its scientific and educational aspects.

"It would also be desirable for the UK to take a leading role, and as rapidly as possible, in the IHP Intergovernmental Council. There are great expectations of seeing British scientific leadership through IHP — either in Africa through the creation of an African Hydrological Research Centre or in the Balkan peninsula by assisting hydrologists in a conflict-torn environment to work together in a FRIENDly atmosphere. Or in the small islands of the humid tropics. Or by offering young associate experts to assist our regional hydrological programmes.

"Well, this is just a short sample of what we could, and perhaps should, do together.

"One particular thing, beyond enlarging the playing field and the number of players, is extremely important. And this is hair colour distribution: it has most definitely become too white, and this applies, of course, first of all to me. We need young hydrologists: the younger generation. The whole programme needs rejuvenating. We need fresh and brave ideas. We need new idealism in our science. We need to build new bridges into the future. We need to start thinking together about how to continue IHP into the 21st century. We need a clear vision on newly emerging hydrology problems and priorities.

"We need, need, need . . . . . Your active cooperation is the most important element in the global hydrological science programme.

"Ladies and Gentlemen, This was my short list. We will work out the long list together — all the 186 nations owning the International Hydrological Programme. On behalf of the Director General of UNESCO, Mr Federico Mayor, I should like to express our joy and happiness over the rejoining of the British hydrological community in IHP and that this time, it will be forever."

About 25 people were present at the reception, among them **Sir Charles Pereira, Dr Jim McCulloch** and others with long-term connections with what has followed from the International Hydrological Decade.

History of the UK and UNESCO

1945	Constitution of UNESCO drafted and signed in London
1984	UK withdraws from UNESCO
1991	Interdepartmental Committee for Hydrology, with Foreign Office help, signs Memorandum of Understanding with UNESCO to have Observer status within IHP
1997	UK rejoins UNESCO as a full member

Members of the UK IHP Committee

Mr F.M. Law (Institute of Hydrology, NERC); Mr R. Vincent (Department of the Environment, Transport and the Regions); Dr S.J. Caughey (Meteorological Office); Mr John Waterworth (Department of the Environment, Northern Ireland); Mr Philip Wright (Environmental Affairs Group of the Scottish Office Agricultural, Environmental and Fisheries Department); Mr Alistair Wray (Department for International Development); Mr Stephen Cox (The Royal Society); Dr David Collins (The University of Oxford); Mr John Burns (Scottish Environment Protection Agency); Mr H.R. Payne (The Welsh Office); Mr Jerry Sherriff (Environment Agency); Mr J. Goudie (Ministry of Agriculture, Fisheries and Food); Professor Mike Hamlin (BHS); Dr J.H. Baker (Natural Environment Research Council).



Dr Andras Szöllösi-Nagy, Director of UNESCO's Division of Water Sciences (right) receives a memento from Frank Law, Chairman of the UK IHP Committee to commemorate the UK hydrological community rejoining the IHP

A review of the IAHS Assembly at Rabat

Vth International Assembly of the International Association of Hydrological Sciences Rabat, Morocco 23 April - 3 May 1997

The Vth Scientific Assembly of the IAHS in Rabat was well organised (once one had become used to the Moroccan concept of time) and well attended, with nearly 450 delegates registering. This is more than for the previous IAHS Scientific Assemblies I attended in Boulder and Vienna. There was an excellent mix of delegates from developed and less developed countries — more so than previous assemblies — and this was reflected in the presentations in the Symposia and in the content of the IAHS 'Red Books'.

I attended the second week of the two-week assembly and focused on Symposium 1: *Sustainability of water resources under increasing uncertainty* and Symposium 4: *Freshwater contamination*. Symposium 1 was well attended and opened with a number of papers on the increasing occurrence of drought events — including contributors from closer to home than may have been imagined, for example **Dick Johnson** (Institute of Hydrology) and **Hilary Smithers** (Environment Agency, North West region). The implications of land-use changes for the availability of clean water featured a paper by **Alan Gustard** (IH), highlighting the integration of water and aquatic ecological management — this generated much debate.

The final session contained some heated discussion following a paper by **Bhanu Neupane** and **Gordon Young** (Wilfrid Laurier University, Canada) which suggested that actual sustainability in water resource management remained improbable. They argued that despite the positive rhetoric of the 1992 International Conference on Water and Environment in Dublin, economic, social and hydrological factors continue to be considered separately, whereas an integrated approach is essential if sustainability is to be achieved. This theme was explored further in an excellent paper by **Andy Dougill** (Salford University) on the sustainability of water resources in cattle ranching areas of Botswana.

Symposium 4 was equally well attended by delegates, but unfortunately the same cannot be said of the presenters. **Bruce Webb**, who convened all the sessions, did an excellent job of shuffling papers and adjusting the time allocated for individual presentations, in the light of around a 30% 'no show' in presenters. This was surprising, given the requirement that presenters had to register for the conference in order to have their paper published in the 'Red Book' for the Symposium. I suspect that the deadline for inclusion in the published proceedings was considerably earlier than for registration. Nevertheless it is a great pity that authors were unable to attend, possibly because of a lack of financial resources, as I noted that many absentees were from the less developed countries.

Despite the obvious gaps in the presentation schedule, some very good papers were given and many of us presenting benefited from the extra time available for questions and discussion. **Michel Meybeck**, past president of the International Commission on Water Quality (ICWQ) started the session with a review of the GEMS: GLORI compendium — an ambitious database on world-wide river discharge. The call for information was followed up with discussion sessions supported by many of the IAHS commissions and committees. **Chris Soulsby** brought us closer to home with an excellent evaluation of recent work on the reversibility of acidification in the Cairngorm Mountains, Scotland. **Bruce Webb** demonstrated his dexterity by both chairing and closing the morning session of the Symposium with a paper on recent work on the link between sediment and phosphorus transport in UK rivers. The afternoon session shifted towards evaluation of heavy metal contamination in fresh waters, with a number of well-presented case studies, including one by **Anne-Marie Bremner** on heavy metal speciation in drainage rhynes near Avonmouth. **Rameshwar Kanwar** finished the session with an extremely detailed evaluation of sources and impacts of water contamination in Iowa.

The second day of the Symposia was opened by the current president of ICWQ, **Jake Peters**, who evaluated the spatial and temporal variation in nutrients in the Chattahoochee River, Atlanta. This was followed by two UK-based papers from **Ian Foster** and **Louise Heathwaite**, both looking at the problems associated with excess nutrient concentrations in fresh waters; the former from a river perspective and the latter from an agricultural runoff viewpoint. The later sessions focus on subsurface freshwater contamination and included papers on water quality and land use in the Nile delta (**Ismail El Ramly**) and groundwater quality in Hungary (**Eva Deseo**).

The final day was cut short by the absence of a number of authors. However, a number of excellent papers were given, including one by **Joop Steenvorden** on modelling nutrient losses in the Netherlands and **Katherine Heal**, on managing manganese concentrations in upland catchments in the UK.

After the conference closed, the delegates went their separate ways: to the hustle and bustle (and hassle?) of the markets to negotiate a price on a rug, or to the relative peace and quiet of the pool-side at the Club Yasmine. Whilst the VIth Scientific Assembly of the IAHS in Birmingham in 1999 will hopefully be bigger and possibly better, it will definitely not be hotter!

Louise Heathwaite
Department of Geography
University of Sheffield

Over 200 papers were pre-published for the six symposia held at Rabat, including authors from over 50 countries. The Red Books of the IAHS Assembly are available from the IAHS Press, who will be happy to supply flyers giving details of the contents of the volumes:

- Sustainability of water resources under increasing uncertainty;
- Hard rock hydrosystems;
- Remote sensing and geographic information systems for design and operation of water resources systems;
- Freshwater contamination;
- Hydrochemistry;
- Human impact on erosion and sedimentation.

Jilly Gash, IAHS Press, Institute of Hydrology, Wallingford, Oxfordshire, OX10 8BB, tel 01491 692442, fax 01491 692424, e-mail jilly@iahs.demon.co.uk; IAHS homepage: http://www.wlu.ca/~wwwiahs/index.html

IAHS at Birmingham 1999

The proposed titles for the IAHS symposia at the IUGG General Assembly in Birmingham (*19-30 July 1999*) are

- Hydrological extremes: understanding, predicting, mitigating;
- Interactions between the cryosphere, greenhouse gases and climate;
- Nutrient loads from diffuse sources;
- Integrated methods of catchment hydrology: tracers and remote sensing;
- Impacts of urban growth on surface and ground water.

New Members

We welcome the following members to the Society:

Bailey, R.P.	Environment Agency
Campbell, C.H.	Water Resources Authority, Jamaica
Corneby, D.	South West Water
Dogangonul, C.	Tirol, Austria
Han, D.	University of Salford
Harris, D.A.	Trinidad
Horobin, R.J.	University of Reading
Imrie, C.E.	Imperial College, London
Jarvie, Dr H.P.	Institute of Hydrology
Lawler, D.M.	University of Birmingham
Lilley, S.J.	Warrington
Linstead, C.	University of Birmingham
Lumbroso, D.M.	Sir Alexander Gibb Ltd
Maggs, G.	Environment Agency, Thames Region
McBain, W.H.	Rofe, Kennard & Lapworth
Patrick, D.	Grantham, Brundell & Farran
Reid, L.B.	Aberdeen
Smith, B.P.G.	University of Birmingham
Wade, A.J.	Macaulay Land Use Research Institute, Aberdeen

Member on the move

Professor Ian Cluckie (Professor of Water Resources in the Civil Engineering Department at Salford University) is moving to another chair — at the University of Bristol.

Travel grants

A BHS subcommittee (the President, the Hon. Treasurer, Dr David Collins and Dr Jim McCulloch) administers the interest from the Exeter Fund and awards travel grants to members.

Grants of up to £150 are available towards the cost of attending meetings. Please provide details of the meeting, why you want to attend, the costs of attending and other sources of finance. Successful applicants are expected to produce a short report.

Any enquiries should be made to the Hon. Treasurer, Dr Richard Harpin *(tel/fax 01793 812479).*

President's piece

As I write my last President's Piece it does not seem possible that three years have passed since I became President-elect. My two years as President started at the Annual General Meeting in Edinburgh and I was very keen to maintain the momentum **Susan Walker** had generated as President. I also hoped that the membership would show an appreciable increase.

Over the past two years the programme of local and regional BHS meetings has continued to flourish. These meetings, organised by a small but enthusiastic group of members, seem to me to be of equal or better quality compared to many meetings organised by some of the bigger Institutions, and at a fraction of the cost. The most recent meeting in London on 'Dealing with Drought: current Issues' organised by **Hilary Smithers** was attended by over fifty people. Six excellent presentations were followed by two lively discussion sessions.

Over the past two years the society has submitted proposals to two external bodies, and although they have been unsuccessful both have given the BHS an opportunity to raise its profile nationally. The first proposal was to the Millennium Commission for part funding to create a thousand-year base of salient hydrological data. This initiative, originally proposed by **Max Beran**, was steered by a small committee chaired by **Ken Gregory** and created an opportunity for BHS to work together with a large number of other groups who would have contributed to the final results. The second proposal to the Royal Society's Hooke Committee was enthusiastically supported by **Sir Charles Periera**. The Hooke Committee sponsor two-day meetings at the Royal Society and provide all the funding, including the cost of bringing a small number of speakers from overseas. This proposal is now being taken up with the Royal Academy of Engineering.

In many ways the drive for new members has been successful, but the total membership has only risen slowly because of non-renewal by some people each year. Last year I appealed to members to write to me with comments and suggestions on how the Society might broaden its appeal, both in the recruitment of new members and in the retention of existing ones, and I am sure my successor, **Frank Law**, would welcome your views.

In the coming two years the Society has much to look forward to. The Salford Symposium next month will give members the opportunity to meet one another, to attend the AGM and to hear the prestigious Penman Lecture (which in Edinburgh was given by **Professor Dooge**). The plans for the Exeter Symposium in 1998 are well advanced: this is BHS's first foray into organising an international meeting. That will be followed in 1999 by the IUGG General Assembly, to be held in Birmingham, and the organising Committee has made special provision for participants under 35 to receive a 50 per cent reduction in the registration fee and inexpensive on-campus accommodation in student residences.

Another significant opportunity for BHS is the UK's decision to rejoin UNESCO. At a meeting in May, sponsored jointly by the Meteorological Office and BHS, a widely representative group discussed how the UK hydrological community could contribute more effectively to the many international programmes. At a reception held at the Institute of Hydrology (*see page 3*) in Wallingford to celebrate the UK's renewed membership of UNESCO, **Dr Andras Szöllözi-Nagy** suggested that the UK should reconstitute its IHP committee. This would provide the opening for BHS to be more proactive in its participation in international programmes.

I would like to thank all those who have served on the committee with me over the past two years, in particular those whose term of office is now coming to an end: **Angela Gurnell**, **Laura Baird** and **Richard Davis**. I am especially grateful to **Richard Harpin**, whose period as Honorary Treasurer ends this year: he has previously served both as a committee member and as Honorary Secretary.

I relinquish my President's role after a somewhat quiescent period of consolidation, but with many exciting opportunities for BHS in the years ahead.

M J Hamlin
President

Impacts of climate change on water resources in the Commonwealth Caribbean

The possibility of climate change in the foreseeable future is a major environmental concern of our times, and introduces additional dimensions of uncertainty and complexity into the domain of water resources management. This technical note points out, by means of two simple but pertinent examples, that notwithstanding the long-term and uncertain nature of climate change predictions, the prudent course of action is to consider the likely impacts of climate change when planning water resource projects, since retrofitting is likely to be more expensive.

The impact of climate change on the water resources of the Commonwealth Caribbean islands, particularly the smaller islands, is likely to be far reaching, including changes in temporal and spatial precipitation patterns, rates of evapotranspiration and hence groundwater recharge. Further, the accompanying sea level rise and the higher amplitude of hurricane-generated storm surges will exacerbate seawater intrusion into critical water lenses and aquifers. These impacts have the potential to create crisis and conflict in the water resources sector, and therefore institutional intervention and advance scientific planning are required for the sustainability of water supplies. This technical note focuses on some of the impacts of climate change on water resources in the Commonwealth Caribbean, and the need for innovation and advance planning for dealing with its uncertainty.

It is well known that our planet is kept warm by the natural greenhouse effect created by carbon dioxide and water vapour in the atmosphere, and that since the industrial revolution human activities, such as combustion of fossil fuels and deforestation, have caused an increase of atmospheric carbon dioxide and other greenhouse gases. Thus it appears that human activities are causing a warming of our planet, but there may be alternative causes, such as an increase in incoming solar and /or cosmic radiation.

Fluid Dynamic General Circulation Models predict that if no measures are taken to reduce the emission of greenhouse gases, an increase in global mean temperature of about 1^0 - 3^0 C and a sea level rise of 15 - 95 cm are expected before the end of the next century (Houghton *et al.*, 1995). Needless to say the wide margin of predictions reflects the many inherent uncertainties. These uncertainties are caused by insufficient understanding of the underlying physics of climate change, especially as it relates to the coupling of land, oceans and atmosphere. Numerical errors, from the use of coarse spatial and temporal grids, and the different possible scenarios of future greenhouse gas emissions introduce additional uncertainties.

Impacts on water resources

Climate change is likely to affect the water resources in the Caribbean in a number of ways (Shrivastava, 1994). Specifically, annual precipitation is projected to increase by approximately 6% in the western Caribbean and decrease by approximately 4% in the eastern Caribbean. Further, changes in rainfall are expected in the dry season. Consequently, the eastern Caribbean may have more severe and longer droughts, whereas the western Caribbean would benefit from an increase in dry season rainfall. As to groundwater, an increase in sea level is likely to increase moderately intrusion of sea water into the alluvial aquifers. However, it is likely to impair water quality severely in shallow water lenses and high conductivity limestone aquifers, which are important — in places critical — sources for public water supplies in the Caribbean (Shrivastava, 1995).

Regional implications

The regional implications relate to socio-economic considerations, public education and intervention and are illustrated with two simple examples.

The first example refers to the likely increase in sea water intrusion into coastal aquifers, which may be caused primarily by sea level rise. This would have a significant impact on the quantity and quality of water available from shallow aquifers and water lenses in islands such as the Bahamas, Barbados and the Cayman Islands. A coconut tree transpires approximately 200 litres of water per day. It may therefore be prudent to selectively clear coconut trees from freshwater lens areas to maximise the supply of water (Falkland, 1992), but coconut trees provide the idyllic setting of such small Caribbean Islands, and from the tourism perspective any selective cutting of these trees will require scientific planning, institutional intervention and public education.

The second example refers to the need to review engineering design standards for the construction of water supply and land drainage projects. This is because such projects may operate in a climate different from the present one. It has been shown by probabilistic reasoning, (Shrivastava, 1994) that it is much more economical to design a drainage channel now taking into account the anticipated sea level rise, than to retrofit the same design in future. Further, climate change would violate the assumption of stationarity of hydrological time series, and the return periods of design storms could change (e.g. a 50-year storm might occur with a smaller return period. Therefore, the existing engineering design criteria and methodology would need to be amended, which would also require institutional intervention and public education.

Conclusions

This brief discussion of the impacts of climate change on water resources shows that there are two options available. The first is to wait and see, and retrofit when climate change becomes undeniably evident: this option is likely to lead to crisis and conflict. The second option is to carry out advance planning and preparedness, in spite of the long-term and uncertain nature of climate change: this appears to be the preferred one, since it ensures sustainability, and leads to advance planning, scientific research, institutional intervention and public education.

I am grateful to Professor H. S. Wheater and Dr A. P. Butler of Imperial College London for their kind support for some of the work mentioned here.

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Gyan Shrivastava
Lecturer in Water Resources Engineering, University of the West Indies

BOOKS

Scaling up using remote sensing

Scaling up in hydrology using remote sensing, edited by J.B. Stewart, E.T. Engman, R.A. Feddes and Y. Kerr, John Wiley & Sons Ltd, Chichester. ISBN 0-471-96829-3. Price £35.00 (hardback)

This volume of 17 externally reviewed research papers is the product of a workshop held at the Institute of Hydrology in June 1996. The theme of scale and scaling in hydrology is extremely relevant as a key research topic in the 1990s and linking it with remote sensing techniques is a sensible extension of this.

The stated objectives of the workshop were to bring together international experts with an interest in scaling-up issues to "assess the current status of the science and identify major gaps in our knowledge". Scanning the list of authors it is difficult to dispute the fact that experts from many different countries were involved, and on reading the book it is clear that the first aim is well covered. However the second aim of identifying major gaps in our knowledge is harder to discern amongst the papers. The major findings and recommendations of the workshop are published in the *International Journal of Remote Sensing*, and it seems a shame that there is no summarising chapter here. This could have identified the overall gaps and brought together some of the discussion that must have followed the papers, but perhaps its omission is a casualty of such prompt publication after the workshop.

The editors state that the papers fall into two categories: looking at the "effect of scale on a range of hydrological measurements", and discussing the "relative merits of current methods of scaling up hydrological variables". In very loose terms these can be seen as practical applications of scaling, and theoretical consideration of scaling techniques. I found it interesting that the majority of papers in the first category are concerned with surface fluxes and roughness lengths, whereas the majority in the latter category are concerned with soil moisture and soil hydraulic properties. I suspect this difference is a reflection of the fact that meteorologists and climatologists have been grappling with scale issues for longer than straight hydrologists, and have developed more techniques to study the effects of scaling.

The papers themselves are extremely interesting, certainly of a research journal standard, and with a diverse range of techniques and results displayed. I found issues of interest in almost all the papers, and the truly international range of authors means that many different hydrological regimes are considered.

Chapter 3 by Menenti *et al.* ends with the fascinating conclusion that the effectiveness of the technique (using an airborne laser altimeter to estimate aerodynamic roughness) highlights problems of theory where "neatly different length scales" are required, the reality of measurement is much more blurred. This is a counterposition to many of the chapter conclusions where it seems the measurements (whether by remote sensing or field) do not match the theoretical requirements.

It would certainly be wrong to say that remote sensing offers solutions to all scaling problems in hydrology: as pointed out by Beven and Fisher in the first chapter, as well as by many other authors in this volume, it is still a long way from having techniques applicable to many of these problems. What this volume does do is bring together many different techniques that are currently being used to answer difficult questions on scale in hydrology, or have the potential to do so.

The only negative points I could find were that the page heading for chapter nine doesn't match the title or content and that only one paper (the final chapter by Stewart) considers the scaling up of temporal rather than spatial scale. These are minor factors, well compensated for by the wealth of good points. The question then arises as to who should (or will) buy this book? In my opinion it is a definite must for any research library (whether institutional or private), because it has a comprehensive coverage of a major hydrological research issue of the present day. It is much harder to justify the cost for a wider audience of hydrologists more interested in the applied side, although at £35 for a clothbound research book it still represents quite good value.

Dr Tim Davie, Queen Mary & Westfield College, London

Scale in hydrological modelling

Scale issues in hydrological modelling, edited by J.D. Kalma and M. Sivapalan, John Wiley & Sons Ltd, Chichester. 1995. ISBN 0-471-95847-6. Price £50.

This book is the second in John Wiley's series called *Advances in Hydrological Processes*. Both books in the series so far have been direct reprints of special editions in the John Wiley journal *Hydrological Processes*. In this case the research papers first appeared as a special issue in Volume 9. The rights and wrongs of this form of publishing can be argued both ways: it provides a means for readers to purchase the special issue without subscribing to the journal in full; equally it can be seen as a doubling-up of published work. Besides that, it is a very good book and well worthy of a read, whether in the journal issue or book edition.

Apart from an introductory chapter, the 26 other contributions represent the edited proceedings of an international workshop held in Australia at the end of 1993. It is poignant to note that one of the convenors, Professor Ian Moore, died just before the workshop took place, and the volume is dedicated to his memory.

In chapter two Blöshl and Sivapalan provide an excellent review of scale issues in hydrological modelling. This is well worth reading as it builds from simple definitions into quite complicated descriptions of key concepts such as dimensional analysis and functional normalisation. This extensive review chapter sets the tone very well for the remainder of the book. There are two other largely review chapters in the book: Band and Moore discuss the linkage of GIS with hydrological models; and Beven looks at parameter estimation and scale dependency in hydrological models.

The remainder of the chapters cover a diverse range of hydrological research areas, looking at scale issues in particular. The only real exception to this is chapter twenty three, by Xinmei *et al*, who cover an interesting topic (meteorological impact of a land use change) but do not seem to fit into the 'scale issues' framework. As an indication of the range of topics covered, there are chapters concerned with: regional variations in flood quantiles (Gupta and Dawdy); shallow landsliding (Dietrich *et al*); soil moisture status scaled from limited field measurements (Kalma *et al*); scaling up to stand water usage from individual trees (Hatton and Wu); surface energy balances over heterogeneous terrain (Silberstein and Sivapalan); interaction between land/vegetation and atmosphere in climate models (three different chapters). The papers display a range of investigative techniques from field measurements through to hydrological modelling, remote sensing and GIS.

As befitting a workshop on scale issues held in Australia, there are two chapters concerned with the Representative Elementary Area (REA) concept. The chapter I found particularly interesting (by Woods *et al.*) looks at the REA concept based on field measurements rather than the hypothetical modelling approach used in previous studies. This study looks at inter storm streamflow and a wetness index, based on two catchments, with subcatchment gauging stations, in New Zealand. The results suggest that at a REA could be identified for the two catchments based on the field measurements but it may not necessarily tie in with available modelling scales.

In summary I would recommend this book as an extremely full and detailed look at scale issues in hydrol-

ogy (not just hydrological modelling as the title suggests). The reservations I have are concerned with the price (£50) and the duplication in publication through the same work also appearing as a special edition of *Hydrological Processes*.

Dr Tim Davie, Queen Mary & Westfield College, London

Climate change and agriculture

WMO Technical note No. 196, *Climate variability, agriculture and forestry*, 1994. ISBN 92-63-10802-1, Price SFr 30.00.

This technical note is the report of the WMO working group appointed to study climate effects on agriculture (including forests) and of the effects of agriculture and forests on climate. The report starts with chapter summaries in four languages, followed by a brief introduction (Chapter 1) to the subjects of climate change and variability, and the effect of these on agricultural and forestry activities that is due to the influence of climate on different aspects of plant and animal biology.

Chapter 2 considers in detail numerous physical responses of plants and animals to climate. As well as direct impacts of changes in climatic variables, the indirect impacts on plant and animal pests and animal food supplies are discussed. In Chapter 3 the impacts of these responses on agricultural activity in different regions of the globe are investigated, using case studies of crops in cold, temperate, tropical and subtropical regions. Forests are noted to be particularly sensitive to changes in climate, and recognition is given to the importance of the Southern Oscillation in pressure, which causes high rainfall variability, affecting agricultural yields in the Pacific region.

The effects of climate variability on agricultural and forestry operations, and measures which should be taken to decrease the sensitivity of agriculture to climate variability, are discussed in Chapter 4. Mitigation measures suggested include a range of factors that would, if implemented, lead to more divergent agriculture.

In Chapter 5 CO_2-induced climate change scenarios from the Villach and Bellagio UNEP/WMO 1987 workshops are used to assess the impacts on agriculture and forests. Results indicate that agriculture in cold latitudes, where at present crop production is limited by temperature, would benefit from climate change. However, in more arid areas, droughts resulting from higher temperatures and lower rainfall would reduce crop yields. If rainfall variability increased, agriculture would need to become less intensive, even if the total annual or decadal rainfall increased. Forests are less adaptable to changes in climate than agriculture, since they are complex ecosystems that take far longer to respond to changes.

The effect of agriculture and forests on climate are dealt with in Chapter 6. Agriculture currently accounts for 15% of greenhouse gas emissions. Forests can have significant effects on climate, with deforestation increasing runoff by 10-20%, and decreasing evapotranspiration.

The report concludes that there is strong evidence for future global warming resulting from the enhanced greenhouse effect, and makes a number of recommendations for mitigating and minimising the adverse impacts of climate change on agriculture — and therefore on human activity. As the title indicates, particular attention is paid to the idea that changes in the variability of climate are of equal or greater importance to changes in the mean. One of the most interesting conclusions is that in all regions of the world, the direct impacts of increased atmospheric CO_2 concentrations **might** cancel out the adverse consequences of changes in climate for plant production.

This document is a very useful handbook for anyone exploring the issues of climate change and land use. The comprehensive chapter summaries at the start of the book allow readers to direct their attention to the chapters that cover their topics of interest.

Miranda Foster
Dundee University

Successor to *Hillslope Hydrology*

Channel Network Hydrology, K. Beven and M. J. Kirkby (Eds.), John Wiley & Sons, Chichester, 1993, 319pp, £60.00.

This book forms part of the Landscape Systems series, a collection covering many aspects of geomorphology. The preface suggests that this book is a successor to *Hillslope Hydrology* (also edited by Mike Kirkby), a publication which will doubtless be familiar to many people. The ten chapters have been contributed by academics based in the United Kingdom, North and South America. Drawing upon many different disciplines, it covers a broad range of subjects. Current research is presented on aspects of sediment and solute movement; network morphology, including long-term changes; unit hydrographs based on geomorphological conditions; flow response and resistance of networks; the channel head, and models of channel networks.

The contributions are of extremely high quality and written in a readily understandable style. The book is well illustrated with many diagrams and photographs aiding the presentation of supporting data and examples. As with many publications made up of contributions from many different people, there is an absence of a common thread running between chapters. However, this is not a major shortcoming, as a reader would generally tend to 'dip' in and out of a book of this type.

An aspect of this book which makes it particularly useful is the presentation of novel data analysis techniques that could be used for other applications. For example, the use of digital elevation data to identify topographic networks, as described by Band. Such an approach could be applied to characterise a number of different geomorphological features automatically.

The chapter by Beven on modelling channel networks and the associated uncertainty brings together many of the aspects covered in previous chapters. This provides an excellent summary and outlines several ideas for the application of the work presented within the book.

Overall, this is an excellent publication, which is highly recommended to students, academics and those working in the water industry. The range of high quality research it presents makes it a worthy successor to *Hillslope Hydrology*.

Douglas Wilson
Southern Water Technology Group

New Dutch publication

The Netherlands Hydrological Society (NHV) has published a book (in Dutch) on automated calibration of groundwater models, based on lectures given at a meeting on *7th November 1996*.

The first part is theoretical; the second describes three case-studies. It gives an overview of available calibration programs. The most important conclusion is that we can no longer calibrate our models the way we did.

There are chapters about:

- Objective functions and parameters
- The reliability of parameters obtained with automated calibration
- A strategy for calibration
- Calibration tools
- Optimisation of a stationary model with MODINV
- Calibration with the aid of Monte Carlo and MODFLOWP
- Structured calibration of an integrated model (SIMGRO) — example

The book is entitled *Modelkalibratie; het automatisch ijken van grondwatermodellen*, edited by H. Boukes and M.R. van der Valk, paperback, 124 pp, illustrated, ISBN 90 803565 1 4.

The book costs DFL 35,00 (postal charges extra) from Nederlandse Hydrologische Vereniging, c/o ir. G. van Ee Grontmij, P.O. Box 203, NL-3730 AE De Bilt, The Netherlands *(e-mail: gmmilieu@knoware.nl)*

Occasional Paper No. 8: hydrology and ecology of floodplain rivers

The latest BHS Occasional Paper contains papers presented at a conference in Birmingham in June 1996 on *Floodplain rivers: hydrological processes and ecological significance.*

The introduction, *Linking floodplain hydrology and ecology — the scientific basis for management*, puts the ten chapters that follow into context.

These cover the role of woody debris (Gurnell), hydrological influences on riparian tree species on a French river (Hughes *et al.*), the influence of plants on floodplain deposition and erosion (Brown & Brookes), the importance of hydrology in the conservation of wetland ecosystems (Wilby *et al.*), management of the Spey river-aquifer system (Chen & Soulsby), the soil water table regime in floodplain grasslands (Gowing & Youngs), a critique of water level management plans (Lawson & Wistow), sustainability and restoration of urban watercourses (Ellis), geomorphology and channel stability in river restoration (Hey) and the impact on flood hydrology at three European river restoration sites (Fisher).

Occasional paper No. 8 (ISBN 0 948540 81 8) is edited by Dr Andy Large of the Department of Geography, University of Newcastle upon Tyne (Tel. 0191 222 6342, Fax 0191 222 5421, E-mail A.R.G. Large@newcastle.ac.uk). There are 130 pages, with numerous illustrations, including a few photographs. The price is £17.50 (£12.50 to BHS members) + £2 p&p. To order, please send a cheque, payable to *British Hydrological Society*, to Professor Angela Gurnell, School of Geography, University of Birmingham, Edgbaston, Birmingham, B15 2TT.

UK–Bulgarian environmental research on sediment transport in rivers

Exchange visits have taken place in the past year between the Bulgarian National Institute of Meteorology and Hydrology (NIMH) and our Institute of Hydrology (IH), as part of the *"Environmental research on sediment transport in rivers"* project, funded by the British Council's Academic Link programme.

The main topics have been instrumentation, measurement networks, database procedures and data analysis (for suspended sediments specifically and hydrometeorology generally). In November 1996, **George Gergov** (Chief of Sediment Transport and Fluvial Processes Division, NIMH) and three of his colleagues (**Katya Pencheva**, chemist; **Valya Stajkova**, hydrologist, and **Alexander Dobrev**, instrumentation) visited the IH York office where the field studies for the Land-Ocean Interaction Study (LOIS) are coordinated. **Graham Leeks**, **Peter Hodgson** and **Paul Wass** received them.

In the context of the first two years of LOIS, Graham Leeks outlined UK practices in hydrometry, suspended sediment monitoring and river mass load estimation. Peter Hodgson described the instrumentation used for LOIS. Paul Wass led a guided tour of three major river gauging sites in the LOIS area maintained by the Environment Agency (EA) and instrumented to measure suspended sediment, turbidity and water quality. **David Leach** described the organisation of water quality sampling and the analytical techniques used in the LOIS laboratory.

The Bulgarian visitors also met EA (Yorkshire) personnel **Darmindr Chadra** (Head of Water Resources), **Martin Wilson** (Hydrologist) and **Robin Bailey** (Flood control). They greatly appreciated the programme prepared for them, which included the flood forecasting system for York and a tour of some of the city flood defences. There was useful exchange of personal experiences, and George Gergov and his colleagues described a comprehensive study (1986-1991) of the man-made Koprinka Lake in Bulgaria, financed by their National Science Foundation. This was more local than LOIS, investigating the impact of the new reservoir on the surrounding environment (local climate change, sedimentation, accumulation of hazardous materials in the sediments, etc.) but some of the measurement and monitoring problems were similar.

In March 1997, **Ian Littlewood and Peter Hodgson** of IH paid a return visit to Sofia, where they discussed the Bulgarian national sediment monitoring network and compared UK and Bulgarian practices in instrumentation, monitoring river water quantity and quality, databasing and data analysis.

Meetings were held at NIMH and at other institutions in Sofia with interests in water: the Ministry of the Environment **(Mr Matev)**, the Institute of Hydrotechnics and Amelioration (**Dr Petkov**) and the University of Architecture, Civil Engineering and Geodesy – UACEG (**Assoc. Prof. Stefan Modev**), as well as at the British Council and British Embassy in Sofia.

NIMH is a component institute of the Bulgarian National Academy of Sciences. Among many other activities, it manages the national hydrometeorological service, measuring key hydrometeorological variables throughout Bulgaria from four regional centres, with 150 climate stations, 435 rain-gauges, 251 river flow gauging stations, 490 observation wells and springs and 112 suspended sediment sampling points (grain size sampling at 60 sites since 1960). NIMH depends on manual sampling by voluntary observers to maintain a national database of suspended sediment concentrations, grain-size distribution, total organic content, mineralogical composition, etc. More advanced suspended sediment/turbidity measurement systems are too costly for regular use in Bulgaria. However, the extensive Bulgarian suspended sediment datasets came from an easy-to-maintain monitoring system using direct observation and measurement. These data are a valuable resource for environmental investigations.

Early Bulgarian suspended sediment records are regularly spaced throughout the year, but observers are now encouraged to sample more frequently during wet periods and particularly during individual runoff events (times of high sediment flux). The suspended sediment monitoring sites are at river gauging stations and,



River water quality sampling using a Solomat water quality probe from a highway bridge in Sofia (photo by I G Littlewood)

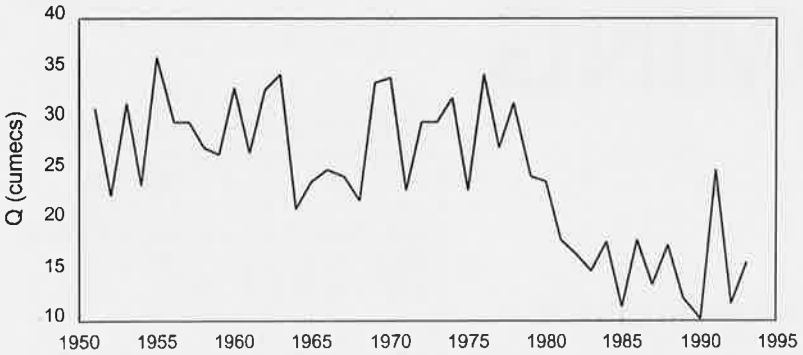


***Figure 1** Hydrograph of annual mean flows for the Lliina River at Britchi Bor (Station No. 192), 1950-1993*

where sampling frequency is sufficiently high, this allows NIMH to maintain flow-concentration hysteresis rating loops continually throughout the year (computers are used to facilitate the derivation). Interpolation gives estimates of concentrations on non-sampled days and can lead to very good annual (and shorter time-step) estimates of suspended sediment river mass loads. Where hysteresis loops are not well-defined throughout the year, mass load estimates are calculated using flow-concentration curves drawn through the scatter of available points.

The Bulgarian suspended sediment database extends from 1952 to the present day and is one of the best in the world. The data are stored on a PC-system. Every effort is being made to maintain this database and improve its accessibility and utility, and IH have provided NIMH with HYDATA (a PC databasing system devised by IH for hydrometric and other data) to assess whether it might be useful for storing Bulgarian national datasets. In return, NIMH gave IH four manuscript volumes of Bulgarian river flow and suspended sediment data (1936-1975). These are stored in the European Yearbook Archive at IH (they have no English translations, but George Gergov is to provide guidance notes).

Ian Littlewood and Peter Hodgson presented a seminar for NIMH staff and colleagues from six other environmental institutes in Sofia. They outlined LOIS, the UK National River Flow Archive (NRFA), the UK Harmonised Monitoring Scheme (HMS) for river water quality, recent IH work to merge the NRFA and HMS databases for systematic estimation of river mass loads, recent UK droughts and UK instrumentation for river flow, hydrometeorology, suspended sediment, soil moisture deficit. Lastly they demonstrated IHACRES, a new rainfall-runoff modelling package for PCs, developed jointly by IH and the Australian National University. A copy was given to NIMH. IHACRES uses a unit hydrograph approach to model catchment-scale rainfall-runoff processes and allows continuous simulation of variable mixing ratio of 'slow' flow (cf. baseflow) to total modelled streamflow. Future collaboration between IH and NIMH will include investigating the use of the IHACRES hydrograph separation facility for understanding the smooth (but time variant) flow-concentration hysteresis loops observed for suspended sediment in many Bulgarian rivers.

The recent UK droughts in the context of climate change generated considerable interest. Bulgarian snowmelt-derived river flows had decreased substantially in recent years. Figure 1 is the hydrograph for the Illiina River (at Britchi Bor) from a paper by Gergov and Stajkova (1996). Clearly, there has been a marked decline in hydrological yield of this system since the late 1970s.

Dr Stefan Modev of UACEG drew attention to a corresponding decrease in seasonal storages in the Iskar reservoir, Sofia's main surface water source.

One aim of the visit was to try out new instrument technology (particularly for suspended sediment monitoring using turbidity) under the difficult conditions encountered in Bulgaria. The suspended sediment load in Bulgarian rivers is often much higher than in UK rivers, and comprises larger particles. Field measurements were made at six sites in and around Sofia (see photo). A UK portable water quality monitor (Solomat 803PS/WP803) recorded water temperature, pH, electrical conductivity and turbidity at each site. Simultaneous manual samples were taken by NIMH staff for comparison. Figure 2 shows the correlation between the suspended sediment concentration (from manual samples) and the turbidity measurements. Further analysis established differences in water quality between the six sites (some of them on the same watercourse), reflecting local domestic and industrial inputs.

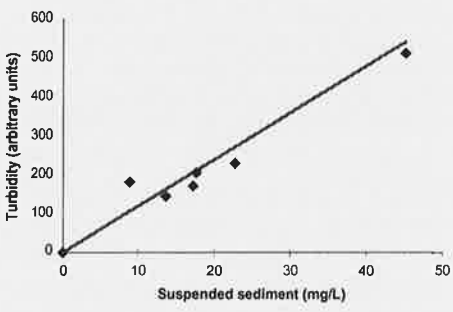


***Figure 2** Suspended sediment against turbidity: six sites in and around Sofia*

Reference

Gergov, G. and Stajkova, V. 1996. Hydrological assessment of the Rila Mountain water resources. *Technical Ideas* (Scientific J. Bulgarian Academy of Sciences), **XXXII**, No.1 (in Bulgarian with English abstract).

Ian Littlewood, George Gergov & Peter Hodgson

Charles Eeles

Colleagues at the Institute of Hydrology and elsewhere were saddened by the sudden death of Dr Charles Eeles at the end of June, aged 66.

Charles William Owen Eeles was an integral part of the Institute from its beginning as the Hydrological Research Unit until he retired in 1991. Initially he worked with the soils section, and was deeply involved in developing the neutron probe for measuring soil moisture, a system now in worldwide use as the 'Wallingford' probe.

His expertise was put to good use in 1969 and 1971-5 when he was seconded to work on catchment studies of land-use change in East Africa. There he produced definitive calibrations for the neutron probes for the wide range of soil types in these catchments.

Thereafter Charles analysed and interpreted the mountain of data from these pioneering studies, and contributed significantly to the final reports and the Special Issue of *E. Afr. Agric. For. J.* devoted to the results.

From the late 1970s Charles became increasingly involved in development and application of models to simulate catchment hydrology and the effects of land-use change, using data from East Africa, the UK and countries ranging from Argentina to Turkey.

Out of this grew a preoccupation with developing techniques for automatic optimisation of model parameters, where he gained a reputation for expertise — in his retirement he completed his PhD thesis on this topic.

Beyond these themes, Charles contributed widely to the work and life of the Institute. He was training officer for many years, and he was mentor to a succession of graduate and sandwich-course students from many countries.

He had a dry sense of humour, and an ability to get to the nub of an argument and ask 'awkward' questions: this could discomfit the pretentious, but guide the serious towards enlightenment. He will be greatly missed by his colleagues and friends in hydrology, and in the community he contributed so much to.

J R Blackie

FORTHCOMING EVENTS

Meetings

Fourth International Symposium on HYDROLOGIC APPLICATIONS OF WEATHER RADAR
San Diego, California, USA
5-9 April, 1998

This is the fourth meeting in a series initiated nearly ten years ago in Salford, and will be held for the first time in the USA. The first meeting and the two that followed (in Hanover, Germany and São Paulo, Brazil) were very successful in bringing together radar hydrologists from all over the world, and vitally contributed to the progress of the field. Hosting the symposium in the USA will give the opportunity to learn first hand about the newly-implemented network of over 100 WSR-88D S-band radars that provide nearly continuous coverage of the country: visits to these sites are planned for the symposium. The meeting will also provide an opportunity to share experience from the rapidly growing number of radar and radar network installations around the world. Scientific results of the symposium will be summarised in a peer-reviewed volume of papers.

Papers are invited on theoretical and applied topics and technology transfer. Extended abstracts are required by **1 November** and decisions on acceptance will be made by **1 December**. Full papers will be peer-reviewed and published after the symposium. Registration forms will be mailed in early January. The registration fee will be $250, including a welcome luncheon, banquet, volume of abstracts and radar site visit.

Direct all correspondence, including pre-registration forms and abstracts to Dr K. P. Georgakakos, Hydrologic Research Centre, 12780 High Bluff Drive, Suite 250, San Diego, California 92130, USA (Attn Ms. Corinne Rice) Tel +(619)794-2726 Fax +(619)792 -2519 E-mail admin@hrc.ucsd.edu WWW http://hrc.ucsd.edu or http://www.iihr.uiowa.edu/meetings

International Symposium on DAM SAFETY
Barcelona, Spain
17-19 June, 1998

This symposium has *Hydrological safety* as one of its four main themes, taking up the morning of *Friday 19th June*. The headings are: criteria and guidelines for design floods; hydraulic design; dam performance in floods; flood control dams, and accommodation to extreme floods.

Papers are invited: send an abstract *(maximum 300 words)* by **30 November 1997** to R Mahiques, Spanish National Committee on Large Dams, ETS de ingenieros de caminos, canales y puertos, UPC, Módulo D1, c/ Gran Capitán, s/n, 08034 Barcelona *(Tel 34-3 401 64 78, Fax 34-3 401 73 57).*

Diary

9th September 1997
Scottish Hydrological Group / CIWEM
"Sustainable urban drainage"
Prof. John Gardiner (Middlesex Univ.)
Venue: Dept of Civil and Offshore Engineering, Heriot Watt University
Contact: Dr Andrew Black, Dept of Geography, University of Dundee *(Tel 01382 344433, fax 01382 344434, e-mail a.z.Black@dundee.ac.uk)*

10th September 1997
Welsh Hydrological Group **AGM**
"Environmental and hydrological aspects of the Wentloog Levels flood protection works"
Contact: Dr Rob Drayton, 208 Fidlas Road, Llanishen, Cardiff CF4 5NA *(Tel 01222 754879, Fax 01222 754879)*

15th - 18th September 1997
Sixth National Hydrology Symposium & **BHS AGM** (***10.30*** *on 16th September)*
Venue: University of Salford
Contact: Dr Kevin Tilford, Dept. of Civil Engineering, University of Salford, Manchester, M5 4WT *(Tel 0161 295 3458, Fax 0161 295 5060, e-mail k.a.tilford@civils.salford.ac.uk)*

21st - 27th September 1997
IAH XVII Congress — "Groundwater in the urban environment"
Venue: University of Nottingham
Contact: Prof. J D Mather, Geology Dept., Royal Holloway & Bedford New College, Egham, Surrey *(Tel: 0784 443625 Fax: 0784 471780)*

1st - 3rd October 1997
FRIEND '97: Regional hydrology: concepts and models for sustainable water resources management
Venue: Postojna, Slovenia
Register by *1st September*
Contact: Dr Mitja Brilly, FGG Hydraulics Division, Hajdrihova 28, 6100 Ljublijana, Slovenia *(Fax +385 61 219897, e-mail mitja.brilly@fagg.uni-lj.si www: http://fgglib.fgg.uni-lj.si/FRIEND97/)*

6th October
British Dam Society evening meeting
"Economics of reservoir asset management and maintenance"
Contact: Richard Howard, Institution of Civil Engineers *(Tel 0171 222 7722)*

18th - 19th October 1997
BHS National Workshop/Conference
"Ecohydrology"
Venue: University of Sheffield
Contact: Dr Andrew Baird, Dept of Geography, University of Sheffield, *(Tel 0114 222 7949, Fax 0114 279 7912, E-mail A.Baird@Sheffield.ac.uk)*

22nd October 1997
BHS Midlands Section / CIWEM
"Climate change: water and environmental management implications for the Midlands"
Venue: University of Birmingham
Time: 13.40 - 17.25 p.m.
Contact: Paul Webster, School of Civil Engineering, University of Birmingham B15 2TT *(Tel: 0121 414 5055)*

5th November 1997
Pennines Hydrological Group
"Reservoir hydrology"
Venue: University of Newcastle
Contact: Dr Kevin Tilford *(see above)*

26th November 1997
Scottish Hydrological Group (AGM)
"Hydroclimatic variability in Scotland"
Prof. Keith Smith (Univ. of Stirling) & Prof. Alan Werritty (Univ. of Dundee)
Venue: Theatre No 3, McCance Building, University of Strathclyde
Time: 18.30 (tea from 18.00)
Contact: Dr Andrew Black *(see above)*

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 £20. Enquiries about membership should be made to Richard Howard, Institution of Civil Engineers, 1-7 Great George Street, London SW1P 3AA. Tel 0171 665 2234, Email howard_r@ice.org.uk. Please address all other correspondence to the Editor, John Griffin, Institute of Hydrology, Wallingford, OX10 8BB. Tel 01491 692395. Fax: 01491 692424. Email b.h.s@ua.nwl.ac.uk.

Circulation is produced by the Institute of Hydrology and indexed in *Geosystems' Hydrotitles* & *GeoArchive* and *NISC HydroROM*