THE NEWSLETTER OF THE BRITISH HYDROLOGICAL SOCIETY

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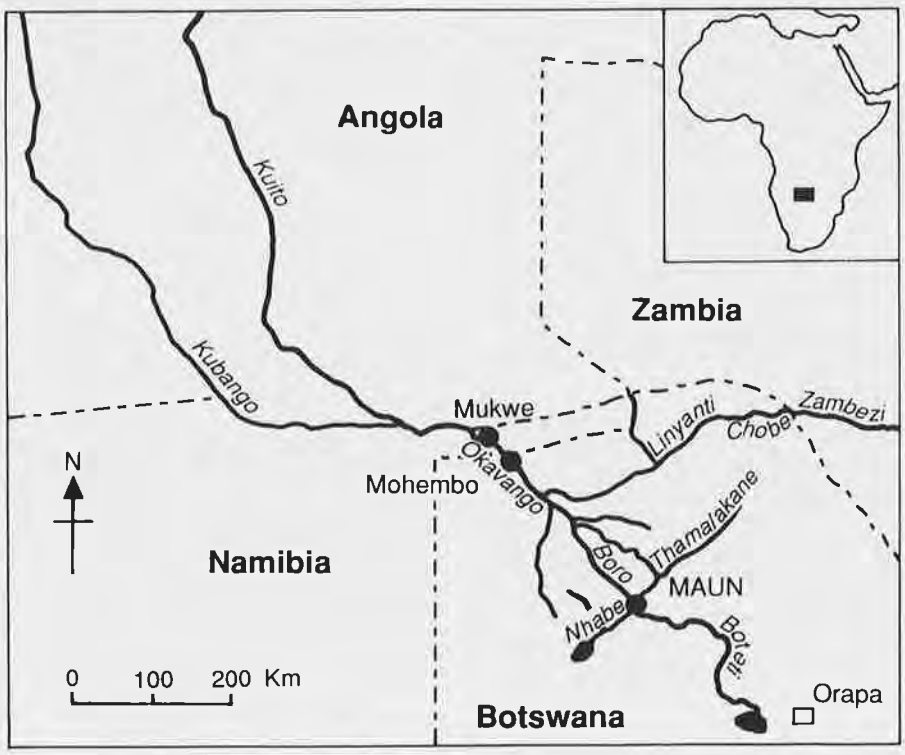
No. 37 February 1993

Reviewing the Southern Okavango Integrated Water Development Project

"It was what every freelance consultant dreams of", writes Ron Manley. **"I came back home and there was a message on the telephone answering machine from someone I had never met, from an organisation I had never before worked for, trying to contact me. When I followed this up it led to an eight-month assignment in Botswana working for the World Conservation Union (IUCN).**

Botswana is one of Sub-Saharan Africa's richest countries, its wealth coming mainly from diamonds but also from the sale of beef and from tourism. And what draws the tourist is the Okavango delta which seasonally floods up to 20,000 km² of the Kalahari desert — which is why the Okavango is sometimes called the Jewel of the Kalahari (*see right*). At its northern end it consists of perennial papyrus swamps, with channels interconnecting *lediba*, oxbow lakes from an earlier stage of the delta's development.

Further south, more of the delta is seasonal swamp, but still with permanent pools and also permanent islands. It is the presence of this permanent source of water which draws the wildlife to the delta. Elephants, giraffe, lions, hippopotami, crocodiles and vast range of antelopes, from the small Steenbuck to the larger Tessebe and Sable Antelope. Fish Eagles are a common sight, and other large birds such as Pelicans and Flamingoes and smaller brightly coloured bee-eaters: over two hundred



species of birds have been recorded in the delta.

The river system in the delta is not stable. When David Livingstone first visited the delta in the mid-nineteenth century the Thaoge river to the west was the main distributary. Flows then became concentrated in the Gomoti to the east. From around 1950 onwards the main outflow from the delta has been the Boro River in the centre of the delta (Figure 2). The River Boro discharges into the Thamalakane and then into the Boteti. Some 200 km down the Boteti is the Orapa diamond mine, which earns a large percentage of the country's foreign exchange and which needs around 5 MCM (million cubic metres) of water each year for processing the ore. Near to the Thamalakane/Boro confluence is the rapidly growing town of Maun which services the tourist industry in the delta.

To meet these two existing water needs and others proposed for the future such as irrigation and riparian agriculture, the Southern Integrated Water Development Project had been under consideration since 1985. The final proposal was to construct three reservoirs, one to control water levels for flood recession agriculture and the other two for water storage, and to deepen and widen the Boro river for 42 kilometres upstream of its confluence with the Thamalakane.

Despite efforts by the government to inform local residents of their proposals, when engineering plant arrived on site to start work violent opposition to the scheme rapidly developed. Part of the opposition was from a deep-seated belief of the local people that changing rivers was against nature and could only be for the worse (earlier ill-advised river works had served only to reinforce this fear) and also from the international community who were afraid of the scar that the channel works might leave on the delta. Following a *khotla*, an open-air public gathering when anybody can participate and express their views, which the citizens of Botswana do with vigour, the government cancelled the engineering contract and suspended the project. The IUCN was invited to conduct a review of the project and, if the project was found to be deficient and another alternative seemed better able to meet the needs, to then outline what was necessary to implement this alternative.

In October 1991 a multi-disciplinary team of 13 members started work. The team leader was a Professor of Development Anthropology from the California Institute of Technology, who had started his career looking at the proposed resettlement plans for the Kariba dam. I was the deputy team leader and the hydrologist, and the other eleven members were drawn from Holland, the United Kingdom, the United States of America and from Canada. These other members included engineers, water resources planners, economists, sociologists, biologists and botanists.

My own assignment started with a few days in the capital of Botswana, Gaborone, followed by a reconnaissance visit to the delta which included a short boat trip and an overflight. After a few more days back in Gaborone, myself, the team leader, a retired aquatic weed control officer with a vast knowledge of the delta, a guide and driver set off on a seven day tour of the delta by boat, stopping each night on one of the small islands in the delta. One night we camped under an African Mangoustan tree which has olive sized bitter-sweet fruit which a family of monkeys regarded as its private reserve — and who came and grumbled noisily at us. Another morning as we were eating our breakfast (tilapia and tiger-fish caught during the night) an elephant came and joined us, tearing down branches a few metres away. Later that same morning we came cross a couple of elephants wading through the river and had to stop the boat to let them cross. (Small wonder our project tee-shirts had the words "I'm not a tourist — I work here" written on them).

After a magical trip it was back to start trying to make sense of the data and to study the reports of what work had been done already. Just before Christmas 1992 I left Botswana, via Zimbabwe, to visit Australia and spend three days in the office of the consultants who had designed the project. Then on to Harvard to brief the project's water resources planner, a professor at the University.

Back in Botswana again I started to develop my own model of the delta. The main data were inflows at the northern end of the delta (10,000 MCM/annum or 316 cumecs), rainfall at Maun and Shakawe and outflows at the lower end of the delta (less than 5% of the inflows). Much modelling work had been done before and although these models had good representation of the annual flows their representation of monthly flows was poor. The main differences I introduced were better representation of the depth/area relationships and a parameter to take account of the water loss as the delta filled up and previously dry areas became inundated. This model gave the hoped-for improvement in monthly flow simulation.

Then in April the team leader and myself started editing our draft report which recommended that the project be terminated. The day it was circulated, in May 1992, the government announced that they had cancelled the SOIWDP because of local opposition and would look at alternatives, including the one we had proposed. Although we had submitted the draft we kept on working and did further work which confirmed and strengthened our conclusions. When we had received comments on the draft (ranging from flattering to abusive!) we produced the final draft which necessitated visits to Harvard (again), Winnipeg to meet the two Canadian team members, Los Angeles to edit the text with the Team Leader and a final visit to the IUCN headquarters in Switzerland to produce the final document.

And what were the conclusions which brought about the varied reaction? First, the sociologists had confirmed that the local people had a deep-seated belief that altering rivers was flying in the face of nature and also, by studying how people lived and what activities they carried out to get food, to demonstrate that even if the project had worked as intended, the local people who were supposed to benefit would in fact be worse off. One of the main reasons for this was that the reservoirs would have eliminated a large proportion of the area of river bed currently used for flood-recession agriculture. Also, by this time the company managing the diamond mine had confirmed that it could get all the water it needed for the foreseeable future from groundwater. This water was, like the diamonds themselves, 'mined' but as, even on the most optimistic estimates, they would only have received river water for 90% of the time they would have had to invest in a groundwater system anyway to ensure continuous production — making the additional cost of a surface water supply system uneconomic.

Our other conclusions demonstrated that, at the very least, there were serious doubts that the project would have worked as intended, as the following shows:

(1) A flow record for the delta inflows was available for 1933 onwards. From 1933 to 1946 water levels had been recorded at a site whose whereabouts are now known only approximately; for 1947 to 1965 there is a composite flow record based on measurements at a number of sites upstream of the frontier with Namibia, whilst from 1966 onwards there is a flow record in Botswana, just downstream of the frontier. For the original study it was assumed that the site of the early levels was close enough to the current ones for the present day flow rating to be used. When these flows were used with the simulation model of the delta they indicted that in 1941 and 1942 there had been no outflow from the delta. We investigated this further using rainfall data from Angola, where the Okavango rises and which contributes almost all the flow, details of two gaugings carried out in 1937 and a comparison of water levels for two periods of more than a decade which had similar rainfall. We concluded that the earlier study had in fact underestimated flows at the entry to the delta by about 20% and that the

water would have flowed out of the delta in both of the drought years of the early 1940s.

(2) It had proved impossible to get a set of parameters for the earlier model which was able to simulate the whole of the recorded outflow of the delta from 1969 onwards. It had therefore been concluded the delta responded differently during different periods or — to use the terminology adopted for that project — there were three different 'regimes'. This effect is shown in Figure 1 which presents double-mass plots of outflow at four points on the system against inflow. For all but the station at Xakue, on the edge of the perennial swamp, the lines are far from straight and there are indeed significant differences in outflow proportion.

At first we were not able to explain these differences other than by a similar hypothesis to that of the earlier study until we looked in more detail at the data. Figure 2 shows a double-mass plot of the two rainfall stations used for the study and two kinks in a straight line can be observed. By plotting each of the stations against groups of other stations we were able to identify which of the two was in error at which date. As the rainfall is affected by movement of the inter-tropical convergence zone, whose variable movement might have caused some anomalies, two separate tests were carried out using nearby and more distant groups of gauges which showed the same changes. The effect of errors in rainfall was magnified in both the models as there is no long term evaporation data, so this was estimated by correlation with rainfall over a twenty year period and the rainfall then used to calculate evaporation. When the rainfall had been corrected it was found that it was not necessary to introduce the concept of 'regimes' and that one set of parameters with corrected data gave almost as good a simulation as three sets of parameters and uncorrected data. When we simulated the long term outflow of the data using the revised model we got flows that were around 50% higher than had been estimated earlier for the project.

Whilst the above were important findings they did not answer the question "Would the SOIWDP have increased flows down the river?". After all, the people living along the Boteti are not very concerned about whether the average flow for the last 60 years has been 200 or 300 MCM: what interests them is whether work on the river will improve water availability. This leads to our two other hydrological findings.

(3) One of the most contentious proposals was for channel excavation of 42 km of the lower reaches of the Boro river. Both sides had their own jargon. Those promoting the scheme used "channel improvements" and the opposition used "channel dredging". To avoid bias we adopted the phrase above "channel excavation". The aim of this —

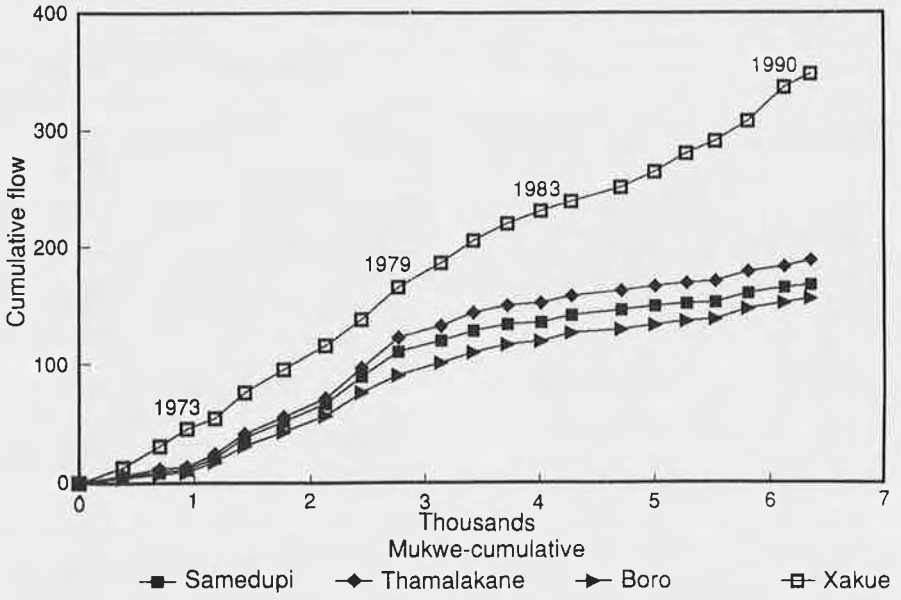


***Figure 1:** Double-mass plot: four outflow stations vs. Mohembo*

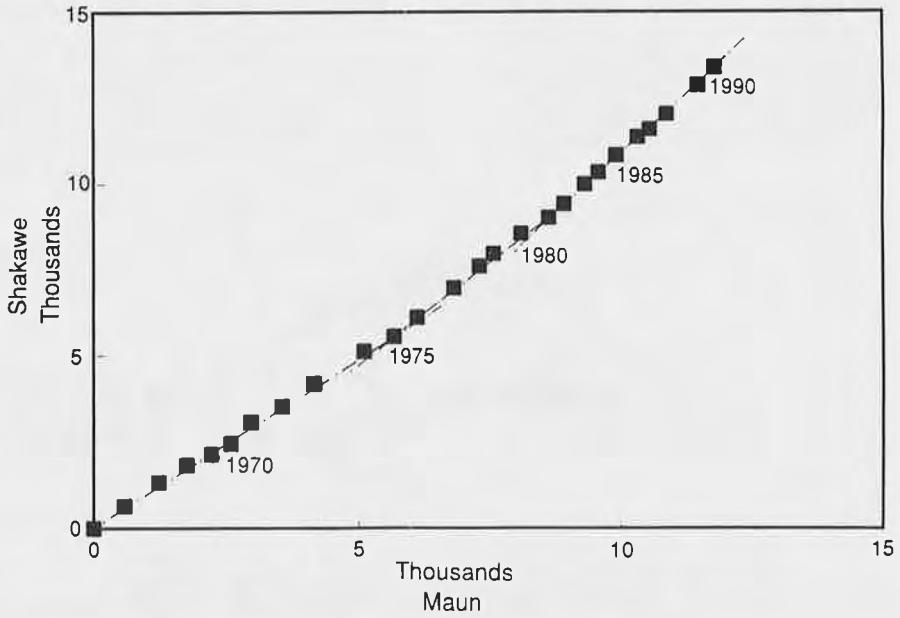


***Figure 2:** Double-mass plots: Maun and Shakawe vs. control stations*

whatever words are used — was to reduce levels for a given flow, thereby reducing flooded areas and in turn evaporation. With less evaporation there would be increased outflow from the delta. The original study calculated that there would be an almost constant annual increase in flow of 40 to 55 MCM. This would have been ideal as there would be good benefit in dry years — when total natural outflow could be as low as 30 MCM — but at the same time minimal effect in wet years when flow would be up to 800 MCM. Unfortunately it is difficult to measure flows within the delta itself, in dry years particularly access is not easy except during the height of the flood and the channels are poorly defined by banks of reeds.

Nevertheless three gaugings were made at the upper and lower end of the proposed works. For the original study these values were used with the delta model, which was linear in its response, to estimate the gain in yield at other times. Our approach was more direct. It was reasoned that the maximum gain in flow would come about if all evaporation losses were eliminated between the upstream end of the channel works and the downstream end; in reality the actual gain would be less than this. This therefore enabled us to define an envelope of maximum gain from the proposed regrading. When this envelope was applied to the calculated gains we found that the average gain was reduced by a half and that in dry years the gain was very small: a very different conclusion to the original study.

(4) The reservoirs proposed for the project were long, thin and shallow and

sited in the bed of the existing rivers. The furthest upstream of the two had an average depth of 2.08 m (compared with the average open water evaporation of 2.17 m), a width of 504 m and a periphery of 258 km. At present the rivers are fringed with trees for a depth of 100 to 200 m. Beyond the trees there is only scrub and bushes. Therefore the trees are getting their water from the river. The amount of this loss which will continue after reservoir construction is difficult to calculate, our best estimate was around 20 MCM/annum, but in any case it will be higher than the zero which was assumed by the original study.

When all these factors were taken into account we estimated that construction of the reservoir would lead to a reduction on flows downstream of the first dam of 26 to 46 MCM. The original study had calculated an increase of 4 MCM. Since one of the criteria for the scheme was that there should be no reduction in downstream flow, this was a serious flaw.

Having satisfied ourselves that the proposals would not have worked, the onus was on us to indicate an alternative. At present the town of Maun gets all its water from shallow boreholes so conjunctive use of this groundwater seemed a good alternative, particularly since our figures suggested that the three-year drought simulated in the original study would not occur. This option is very attractive financially, with resource development costs of £ 1.1 million compared to £13.9 million for the channel excavation and the first of the reservoirs. We also believe that conjunctive use has an even bigger advantage. The demand for Maun will reach 4 MCM early next century. The evaporation loss from he reservoir averages 68 MCM/annum and the seepage loss is 20 MCM/annum. The demand is therefore small compared to the losses. Further, in a serious drought it would not be possible to effect any significant conservation of resources by demand management. Once the reservoir was dry, that would be it. By monitoring the boreholes on the other hand, demand management could successfully be introduced. Even the existing boreholes could provide enough water for basic domestic needs but, of course, to meet future demands the number of wells and the aquifers used will have to be increased.

This type of study — looking at the work of other professionals — is always difficult. There is a danger that you criticise the methodology simply because it is not what you would have used. Although you try to be dispassionate it is not easy to remain completely objective: as anybody who has developed a model knows, if you criticise someone's model you criticise their soul. Despite the fact that the conclusions of our final report have yet to be accepted by the government we believe we have shown is that it would be inadvisable to proceed with the project. There are also areas where we admit that neither our findings nor those of the original study can be relied on and further works is needed. For example, neither of the models considers the channels explicitly.

In a short article like this it is impossible to present all the arguments. The report of the review team is however shortly to be published by the IUCN so anyone who wants to can get a copy and learn more about what was a fascinating study.

R E Manley, Cambridge

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Preferential Transport of Sediments and Solutes from Uplands to Estuaries

BHS National Meeting
University of Leeds
21 September 1992

The meeting examined the supply, transport and storage of different particle sizes through the river basin, with particular emphasis placed on fine sediments (clay and silt) because of their association with soil erosion and the transport of adsorbed contaminants. Seven of the papers examined different aspects of particle transport, descending from the headwater regions to the estuary. The opening and concluding papers took a wider view of the transport processes integrated at the catchment scale. Thirty-eight people attended the day-long meeting and were welcomed to the Department of Geography, University of Leeds, by Professor Mike Kirkby.

In the opening talk **Dr Patrick Holligan** (Plymouth Marine Laboratory) described the Natural Environment Research Council's Land-Ocean Interaction Study (LOIS), for which proposals had recently been solicited. Central to LOIS is an improved understanding of the processes determining exports of sediments and contaminants from river basins to the coastal zone and the subsequent impact of these materials on marine ecosystems and shelf and coastline evolution. Means of predicting the effects of land use and climate change on the fluxes of materials are to be developed but these should not be too sophisticated. Current understanding is limited more by data availability and the greater need is for improved observational networks and process studies. LOIS will therefore involve substantial monitoring of the fluxes from the Yorkshire Ouse/ Humber and the Tweed into the North Sea. In discussion Patrick noted the difficulty of finding sufficient reviewers to vet the 200 proposals submitted for funding!

Dr Bob Evans (University of Cambridge) then examined the sources of sediments in UK catchments. Upland moorlands provide material through peat erosion, landslides and channel bank collapse, with the effects often aggravated by land use changes such as afforestation. Much of the fine material entering the river system is then carried clear of the headwater regions altogether. Further downstream, in the predominantly pastoral piedmont zone, there is considerable reworking of deposited material through bank erosion but the number of sources is few compared with the uplands. Further downstream still, in the arable lowlands, soil erosion can be high depending on the soil type but the proportion of eroded material delivered to river systems is low. Roadworks and construction sites often form more important sources. Moorlands are therefore the dominant source of fine materials in UK river systems but there is a need for field data to quantify the various contributions. Means of obtaining such data were reviewed by **Dr Tim Burt** (University of Oxford), concentrating on sediment transport in headwater agricultural catchments. Tim noted in particular the difficulty of determining how much of the soil



***Figure 1:** Bank erosion along the South Tyne near Featherstone Castle*

eroded at the plot scale enters the stream system. Taking studies at the Slapton catchment, Devon, as an example, he presented a set of techniques for providing data on runoff, erosion and solute transport at different spatial and temporal scales. These included plot rainfall simulators, large hillslope measurement sections, and lake cores providing long term records of sediment yield. He concluded with a discussion of the role of catchment management in reducing the effects of non-point source pollution, suggesting that set aside be used constructively to create buffer zones along rivers. Responding to questions Tim stressed the need for detailed process studies to understand the responses of individual catchments.

Wading into the river system, **Professor Rob Ferguson** (University of Sheffield) considered the longstream and vertical sorting of coarse sediments in upland channels. The ready availability of a wide range of particle sizes (sand to boulders), contrasting with the limited transport capacity of the flow, results in characteristic size sorting patterns. Finer sizes have a weight advantage for longstream transport but this is partly cancelled by their tendency to become trapped behind large sizes. Nevertheless downstream fining is observed. Abrasion is not sufficient to explain this but size selection can, as Rob demonstrated using a mathematical model. Vertical size sorting, producing surface armour layers, can be related to sediment supply: if the sediment input is reduced, the bed coarsens as the finer sizes are removed. Rob concluded with examples from Papua New Guinea and the Tyne system demonstrating the responsiveness of the bed surface texture to inputs of mining waste.

Dr Mark Macklin (University of Newcastle upon Tyne) continued the fluvial theme by examining heavy metal dispersal and storage in river basin sediment systems. Taking the Tyne and the Vistula (in Poland) as examples he showed how toxic metals (from mining waste and World War 2 chemical works respectively) can be transported by rivers, deposited overbank and then remain in place for decades or centuries. Valley floors become grossly polluted, with poor crop performance in riparian zones. Metal remobilisation is caused by vegetation changes and bank erosion (Figure 1), processes which are often aggravated by human activity. The first priority in controlling the cycling of the metals is finding their location. Research is therefore needed on metal contamination maps, GIS metal databases and long-term sediment budgets. Answering questions Mark noted that flood events can release heavy metals stored in the channel bed to produce high-concentration pulses of contaminant.

Drifting to more lowland rivers **Dr Paul Carling** (Institute of Freshwater Ecology) examined fine particle dynamics in mixed flow and slackwater environments. Noting that fluxes of fine particulates may be affected by storage and deposition mechanisms evident at the reach scale (for example, flow separation and interstitial storage), he proposed that these should be accounted for by a "dead-zone" deposition model. He described the development of such a model and its need for information on local hydraulic variations in the flow, especially the vertical velocity component. He then presented the results of a test of the model which showed the accumulation of fine sediment in dead zones during periods of low flow and its subsequent release by freshets (Figure 2). Questioned on the importance of turbulence he affirmed that turbulence should be considered because of its influence on the settling of fines but that the model accounted for it within the vertical velocity component.

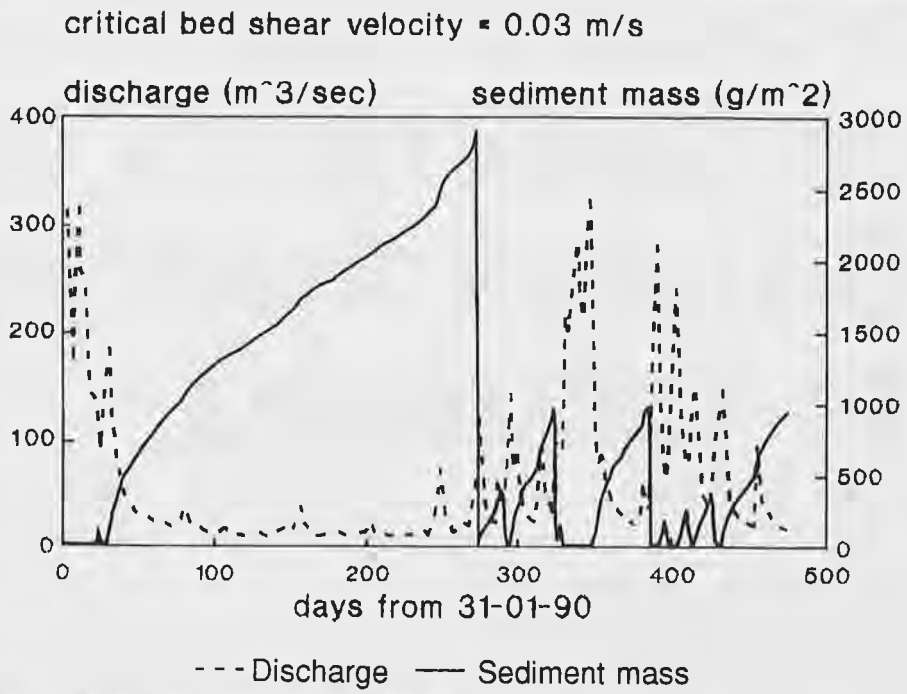


***Figure 2:** Simulations with the dead-zone model, for a given critical shear stress. Calculated sediment mass accumulated is shown by the solid curve (right ordinate), discharge by the broken line (left ordinate).*

In the first of two talks on the end of the sediment transport system, **Dr Ian Foster** (Coventry University) discussed the role of lakes and reservoirs in trapping sediment and forming a record of past sedimentological activity. He began by noting the uncertainty over just how many lakes and reservoirs there are in Great Britain: an estimate based on the 1:63,360 scale maps (ah, nostalgia!) suggests 81,092. Cores from sediment deposits provide reasonable estimates of short to medium term suspended sediment yields, although yields for specific events are less easily determined. Cores can also show historical changes in inputs from which inferences can be drawn on sources. Figure 3, for example, shows that the change in reconstructed sediment yield since 1942 in the Old Mill Reservoir, Devon, is independent of sediment source as revealed in the magnetic signal which shows a single dominant hydrological event, possibly in 1987. Finally cores can provide information on catchment processes over short to medium time scales. In discussion Ian stressed that cores are more satisfactory for providing trends in suspended sediment yields rather than absolute values.

Dr Reg Parker (Blackdown Consultants Ltd) then discussed the transport pathways, material properties and behavioural properties of fine sediments in estuaries. He noted that estuary muds behave very differently from the noncohesive sediments typical of rivers. For example, in the characteristic sequence of settling, deposition, consolidation and resuspension of muds, the critical shear stress for erosion varies with time. Quantification of an erosion threshold is complicated by the non-Newtonian fluid behaviour of mud, the uncertain location of the cohesive boundary and the combination of hydrodynamic, rheometric and viscometric factors operating. Reg stressed that it was therefore important to measure sediment properties in situ: handling sediments on the way to the laboratory modifies their stress history and removes them from their natural environment. In discussion he likewise emphasized that sediment models for estuaries should not be oversophistic-

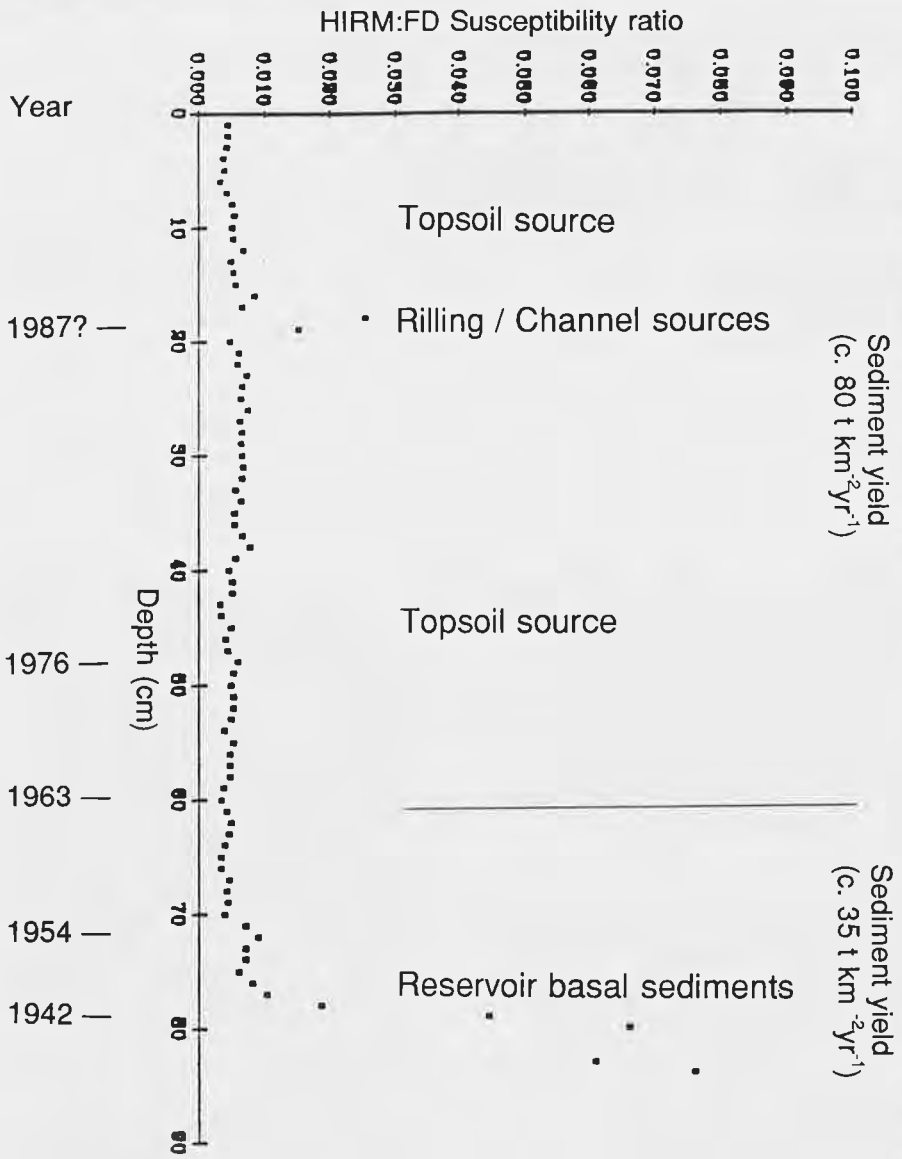


***Figure 3:** A magnetic signal in a sediment core from the Old Mill Reservoir, Devon. Dates are derived from ^{137}Cs analysis and sediment yields from multiple coring and sediment volume estimation .*

ated but should concentrate on those processes for which there is some understanding.

In the final talk, my own, I returned to the integrated view of the sediment transport system as represented by the SHETRAN-UK water flow, sediment transport and contaminant migration modelling system being developed by the Water Resource Systems Research Unit, University of Newcastle upon Tyne. SHETRAN-UK simulates soil erosion by raindrop impact and overland flow, and sediment is routed by size fraction in overland and channel flow, with particular allowance for the behaviour of the fine cohesive particles. Spatial variation is represented by a grid square system and I presented results demonstrating the ability of the model to account for variations in erosion across a small catchment, as well as for the integrated yield at the outlet. However, in common with other models, it is difficult to evaluate the model soil erodibility coefficients from measured property data, so that an initial calibration of the coefficients is required. Experience with SHETRAN-UK emphasizes the need for field based measurements of parameters and data.

In a final half hour of discussion we considered the degree to which the various aspects of the sediment system can be drawn together in a modelling system such as SHETRAN-UK, for use in projects like LOIS. Overall such a system provides a framework for representing the erosion, transport and deposition of sediment throughout a catchment. However, the lack of quantitative understanding of certain processes (especially the transport, storage and consolidation of cohesive sediments) and of the spatial scale dependency of model parameters remains a hindrance to model development. An important theme of the meeting was thus the need for field process studies and data collection to support model development and validation.

The practical importance of sediments and contaminants for water quality was emphasized dramatically when a member of the National Rivers Authority at the meeting was called away to deal with potential pollution problems arising from the explosion that day at the Hickson and Welsh chemical plant at Castleford, West Yorkshire. It was thus a little disappointing that rather few representatives of the water industry attended the meeting. On the other hand, additional participants were gained by running the meeting immediately prior to the Second International Conference on Hydraulic and Environmental Modelling of Coastal, Estuarine and River Waters, which was held at the University of Bradford during 22-24 September. An enthusiastic atmosphere prevailed throughout the day and each presentation attracted interested, and interesting, comment.

Finally, thanks are due to Professor Mike Kirkby and the University of Leeds for hosting the meeting, and to Pam Naden (Institute of Hydrology) and Mike who, along with me, chaired the sessions.

James C Bathurst
University of Newcastle upon Tyne

Circulation now indexed in *GeoArchive*

The major contents of *Circulation* are now being abstracted for the GeoSystems' bibliographic database *GeoArchive* and its associated printed bibliography *Hydrotitles* (copies in the Library at the Institute of Hydrology). Some readers to might like to consider this a reasonable inducement to submit more contributions if they know that there is a mechanism for bringing their work to the attention of a wider audience. *GeoArchive* is a worldwide geoscience and hydroscience database used to reference a mass of published sources including maps, serials, books, conference proceedings, doctoral dissertations, and technical reports. It claims to add up to 60,000 citations each year from approximatley 5000 serials and 300 publishers. Although mainly geological, the coverage of the database does include hydrology and hydrogeology. It is shortly to be issued also as a CD-ROM.

The Management of Scarce Water Resources

IWEM Annual Symposium co-sponsored by BHS 13-14 October 1992

This two-day meeting in the Old Ship Hotel, Brighton, was a fine example of how such meetings should run, *writes BHS Editor Celia Kirby*. There was a decent-sized audience, adequate presentation facilities, comfortable seating, efficient organisation, good food and — most important — a good range of well-presented papers to a receptive audience with mixed interests which prompted spirited discussion. [In fact, just how you might describe a smaller version of our own *National Hydrology Symposium*.]

The technical papers were published beforehand for delegates (and are still available from IWEM's Conference Office at £20.00 for IWEM & BHS members, £25.00 for non-members) and have also gone before IWEM's editorial board: selected papers will subsequently appear in the IWEM Journal. It seems sensible therefore to concentrate on trying to give a flavour of the presentations to whet your appetites rather than to hog *Circulation's* limited space to reprint all 15 papers.

Hugh Speed, the President of IWEM, introduced the meeting and naturally made great play of the timeliness of this Symposium, given that (in early October) we couldn't yet know if we were at the end of a 4-year drought, in the middle of an 8-year one, or even having to learn to adapt to a new clima-tic regime. With public consumption now comprising 4% of total runoff, there were many important points to consider.

The Keynote Address was made by **David Maclean**, Minister for the Environment and Countryside, who took as his theme his Department's discussion paper "Using Water Wisely". Mr Maclean was concerned by our present over-use of water (*his words, not mine*) which needs examination. The past solution to rising demand has simply been to find new resources. Now we need a different kind of action, and the choice seems to be to increase supply or to reduce demand. He thought the former would be the most attractive engineering solution but it would be expensive: not only the development costs but also those of meeting EC directives must be added to consumer costs.

Once we accept that water is in short supply it makes sense to cut down on demand. Water conservation can no longer be a response just to drought conditions. It is consumers who must be the main focus of education in reducing demand because domestic users are the majority. He felt that little was likely to be achieved by voluntary action: it will take obvious incentives, such as paying for all the water used, to make any impact.

The Minister also raised the matter of the considerable amounts known to be lost by leakage and was obviously pleased that the emphasis on this partial solution to the supply problem which is being made by the Director of OFWAT and the NRA is putting pressure on water plcs to take action.

"Incentive charging" for water abstraction is being actively considered, stated Mr Maclean, acknowledging the difficult problems to be solved, and therefore welcoming IWEM's views.

Among other solutions to which he referred was limiting the capacity of plumbing appliances and replacement of obsolete fittings: it could even make economic sense for plcs to provide and fit new appliances in homes rather than to expand capacity. Next, the role of the Bye-laws which need reviewing to take account of the economy: this exercise is likely to follow the lines of Building Regulations, with updates as newer techniques come on-stream which permit greater energy savings and improvements.

The existing regulations on sanitary and drainage requirements need to be integrated with supply considerations and also integrated with EC standards. Here, as befitted a government minister, he observed that harmonisation cannot be uniform throughout the Community: there is a need to preserve national standards, e.g. keeping the best existing UK practices.

He went on to stress that industry needs to think more about recycling and re-use, noting that the NRA's powers are under debate. Should firms be given incentives to discharge at the optimum places? Could dual supplies have a future? What about incentive charges for industrial abstraction and discharges? Views on all these topics are being sought.

Water metering trials are nearly complete and it is clear that the costs of installation and maintenance are likely to come down. The Minister believes there is a strong case for meters in selective areas, especially where the costs of supplying additional resources are high, but he added a note that the Government has prohibited the use of the new Council Tax as a basis for charging water rates.

Finally, he returned to the need for more public education on water use and economy. We must get this message over, particularly in schools, since there is a general lack of understanding by the general public. The profession has an important role in education, he said.

"Water which falls today, is *not* free in our taps tomorrow".

Mr Maclean concluded by reminding us that the consultation process lasted until the end of October, with an *Action Plan* to be published in 1993.

The Symposium proper

The papers that followed over the next two days covered many aspects of water resource management, from putting the current drought in a histor-ical context (**Tim Atkinson** using a 300-year water balance record at Kew, **Sue Bryant** using the National Water Archive held at Wallingford) to coping with drought impacts on a large reservoir with strong environmental interests to protect (**F Knights**, Manager of Rutland Water), and on to the feasibility of introducing new technology such as loos which use less water (part of **Chris Binnie**'s presentation).

The complete programme was as follows:

Paper 1 Modern and future droughts in the context of a 300-year water balance record from Kew, Surrey
Dr T Atkinson, Climate Research Unit, University of East Anglia

Paper 2 Global climate and rainfall - current state
Dr V G Boldirev, Director, World Climate Programme Department, WMO

Paper 3 Overview of climate change and future rainfall predictions
Dr P R Rowntree, Programme Director, Hadley Centre, Meteorological Office

Paper 4 Droughts of uncertain duration in British and Northern European rivers
S J Bryant, N W Arnell and F M Law, IH

Paper 5 Maintaining supplies in adverse conditions
R Miles, Southern Water Services

Paper 6 Operational implications of drought on reservoir management
Allan Lambert, Manager, Hydrology & Water Resources, Wallace Evans

Paper 7 The impact of recent climatic conditions on agricultural water requirements
P B Leeds-Harrison, Silsoe College and M D A Rounsevell, Soil Survey & Land Research Centre, Silsoe

Paper 8 Wetland management strategies in water-stressed conditions
Dr P Denny, English Nature

Paper 9 The effects of low rainfall on the quality of surface and groundwaters
I M Adams, NRA Thames Region

Paper 10 Effects on public amenities and recreational facilities
F Knights, Anglian Water Services Ltd

Paper 11 A better future for Anglian rivers
R Cook, D Evans and P Barham, NRA Anglian Region

Paper 12 Demand and demand management
C J A Binnie, Director, W S Atkins Consultants

Paper 13 NRA national strategy and planning for the future
Dr C J Swinnerton and J D F Sherriff, NRA

Paper 14 Water resources development - a balanced approach
P T McIntosh, formerly Environment Director, Thames Water Utilities Ltd

Paper 15 A most precious resource
Lord Crickhowell, Chairman NRA

It was interesting to note the observations made by many on the "practising" side of the industry that public perceptions are now having an effect on management decisions. For example, there has been a fall in demand this summer *without* resort to Drought Orders (**R Miles**) which demonstrates that the public will respond if the media are well managed. This point was acknowledged by others in the discussion, raising the interesting dilemma that if demand is cut, so is revenue, and in business terms that is equivalent to cutting your own throat! The Public Relations aspect was one that interested me personally and in particular the repeated comment that we have got to get through to children.

Back to operational matters, and the plea that because of the uncertainties, we ought to be building bigger margins into planning. There must be firmer steps taken towards demand management and improving and conserving resources. Citizens everywhere are being encouraged towards the concept of "sustainable development" through the influence of the reports on the Earth Summit at Rio de Janeiro last June. Thus, the water industry cannot be seen to be doing otherwise.

As you might expect, the issue of water meters popped up repeatedly, several people returning to the point that if meters are in place, the public will expect to be able to use water when *they* want to: the overall effect will be quite different to hosepipe bans.

Likewise, the more obvious point that there are gains as well as losses in environmental management was voiced several times in different guises. For example new reservoirs create new habitats which perhaps combat the habitat losses caused by abstraction conflicts. The problem of how to quantify environmental improvements is evidently going to be a taxing task for the NRA.

Lord Crickhowell's summing-up concentrated on the need to re-emphasise that water is a scarce and limited resource, something which is recognized everywhere, for example in the acknowledgement by American politicians in the mid-1980s that shortage of water was one of the two greatest problems in the USA. Here at home, he reminded us that in *Using Water Wisely* there is the statement that the Government will "introduce measures to limit and control demand in the south and south-east".

Turning to the metering debate, he saw the value of metering in giving information on patterns of water use, which are at present only guessed at. Perhaps of more interest to his audience, however, he went on to disclose that the NRA has a project in hand to investigate the benefits and disadvantages of setting MAFs.

Finally, like all good closing speakers, he finished on an optimistic note: the recent drought has concentrated the mind in recent years in a way that has not happened for many decades, and water affairs in this country will develop more robustly as a result.



*This cartoon by **Meirion MacIntyre Hughes** (Wallace Evans) was used in **Allan Lambert**'s presentation: it says it all for many of the audience!*

Stormwater Modelling in Small Urban Catchments

Midlands Section Meeting
The University of Birmingham
4 November 1992

Forty members and guests attended this meeting to hear Andy Eadon, Regional Sewerage Engineer for Severn Trent Water, talk on the practical aspects of stormwater modelling, and Martin Osborne of Hydraulics Research who described some of the developments currently being undertaken at HR Wallingford.

Following a general introduction to the problems posed by sewers, **Andy Eadon** introduced the typical levels of service which act as a trigger for remedial action. Under Department of the Environment regulation embodied in DG5, sewerage systems are regarded as unsatisfactory if flooding incidents due to hydraulic overloading occur at a statistical frequency of more than twice in 10 years. This requirement is the driving force for much of the analytical and physical work currently being undertaken by sewerage authorities. This takes a variety of forms based around Drainage Area Plans or Surveys (DAP). Central to the DAP is the collation of hydraulic information about the sewer system and its analysis using appropriate hydraulic modelling tools.

Recently, Severn Trent Water have undertaken a retrospective analysis of drainage systems designed using the traditional hydraulic design criteria in WASSP-HYD. A key feature of this procedure is the use of a design storm with the same return periods as the acceptable frequency of flooding. Several drainage systems that had been designed using WASSP-HYD were remodelled using WASSP-SIM in order to assess the flooding frequency for each node in the redesigned system for a suitable range of design storms. The results of this analysis are summarised in Table 1 and suggest that the traditional design criteria result in systems that are over-designed.

These somewhat unexpected results have pointed the direction for future action, which is principally to:

- relate the results of WASSP-SIM to the actual performance of the drainage system;
- specify design criteria with respect to the simulation model and simulated flooding rather than the design tool.

The opening theme of **Martin Osborne's** presentation was the scarcity of hydrological data relevant to the theme of the meeting. A relatively small number of flood events from an equally constrained range of catchments have been comprehensively analysed in arriving at the current state-of-the-art of hydrological modelling in urban areas. Martin then proceeded to brief the meeting on investigations that are currently underway at HR.

The investigations at HR have focused on some of the weaknesses of the existing procedures - the identification of the weaknesses no doubt being somewhat easier than their revision. The revisions that Martin presented included a revised model for the paved and pervious area proportions of a catchment and a model for the calculation of the antecedent precipitation based upon soil type.

Further limitations of the existing procedures were thought to relate to the specifications of design rainfall. The use of annual maximum series for example has limitations in the context of the relatively low return periods that characterise much urban drainage design. This has prompted the investigation of the use of annual, continuous time series as the input to models in order to better define the frequency with which threshold conditions are exceeded. Not surprisingly, this 'data hungry' approach leads to a requirements for the analysis of a very large number of storms. However, in addition to other benefits, the technique did illuminate some of the problems of specifying catchment wetness. Typically it is specified on a seasonal basis, whereas the time series approach suggested that much higher values may in fact occur during periods of more prolonged summer rainfall.

Future developments at HR will include:

- further modification of routines, especially those relating to infiltration for tropical and sub-tropical regimes;
- limits on the entry of stormwater in to the sewer system, with its impact upon local surface flooding;
- further investigation of rainfall time series.

The two presentations provoked lively discussion and further questions for the presenters. The Meeting Chairman, **Paul Webster**, then thanked **Andy Eadon** and **Martin Osborne** on behalf of the audience for their presentations.

Paul Webster, Birmingham

Table 1 Summary of Modelling Results

Design Storm Return Period for no surcharging (WASSP-HYD)	*Storm Return Period causing onset of simulate flooding (WASSP-SIM)*
1 in 1 year	2 - 5 years
1 in 2 years	3 - 6 years
1 in 5 years	30 years

New IH Report

The Institute of Hydrology has just published Report No. 108, "Low Flow Estimation in the United Kingdom".

A successor to the Low Flow Studies report (1980), it contains procedures for calculating low flow statistics from observed data and estimating low flow statistics at ungauged sites. A key improvement is the use of the provisional HOST database. There are extensive appendices of low flow statistics.

It may be ordered from the Librarian, Institute of Hydrology, Wallingford, OX10 8BB, price £30.



Desert Island Diskettes

BHS Southern Section Meeting
10 December 1992

Two would-be castaways, Robin Wardlaw of Mott MacDonald and Frank Farquharson of the Institute of Hydrology, were taken to a mysterious island. The island experiences climate ranging from arid to tropical, and is subject to both extreme flooding and devastating droughts. The local institutes that collect and manage hydrometric data are crumbling, technical advice is desperately sought and the Government is planning several large water resources projects. The locals do not speak English, telecommunications are unreliable and software viruses are endemic.

Robin started off by outlining the software requirements for the collection and management of hydrological data. Software should not only improve data quality, but should also improve data capture. Geographical information systems (GIS) are becoming standard, but the Hydrologist should ensure that the system is flexible to the client's demands, is easily upgradable and uses appropriate techniques for the local practices. Robin cited WIS as an example database package.

Technical assistance is normally sought for specific projects, and Robin's colleague at Mott MacDonald, Brian Dunlop, demonstrated the Nile Irrigation Management Package developed by Mott MacDonald for the Egyptian Ministry of Water Resources. The use of interactive computer graphics enables the user to home in on any part of the Nile system, define the cropping pattern for the forthcoming season, set the controls on the irrigation delivery system, and then monitor the performance of the system under a range of releases from Lake Nasser. In a matter of minutes the user can obtain performance figure that previously took five and six people up to two months to prepare. Furthermore, the optional use of Arabic ensures that the model can be used by a whole range of users from local management to ministerial level.

Robin demonstrated a second package developed as a training tool for irrigation managers of the Mahakali region of Nepal. This showed how computer graphics can provide a powerful interface with a complex operational model for the input of data and the presentation of results. The software enables engineers and managers to get a feel for how the system works by playing a computer game.

Finally Robin tackled the problems of project evaluation and design. The Hydrologist may only have a short input, providing data from the design team, consequently he/she must be 100% self sufficient, offering a complete service. General software should include a word processor, spread sheet, compiler and a graphics package. In addition Robin included a communication kit to enable inter-computer data transfer both within the island and internationally via a modem, a virus tool kit is now essential, and a set of systems disks for those del*.* moments.

Robin included favourite routines for quality control (cross correlation, double mass analysis etc.), stage discharge analysis, time series analysis and data reporting. For flood hydrology Robin goes fully prepared for ungauged catchments by including at least one rainfall-runoff model. He suggested the United States Soil Conservation Service method (USSCS) as one example.

Robin concluded his talk by demonstrating a water balance model developed by Mott MacDonald for catchment studies in Bangladesh. The variations of annual rainfall and low relief put extreme demands on any software and this emphasizes the need for a flexible approach to any project and the importance of re-appraising methodologies in the light of the results.

Robin made his escape and left us with a slide of Bali, a somewhat idyllic desert island in Indonesia and one where many Hydrologist would not object to being a castaway.

The second castaway, Frank Farquharson, declared that he could not find eight packages, and that there is always something new needed for each project.

Like Robin, Frank always carries a spreadsheet, compiler and communications software. Spreadsheets are extremely versatile and ideal for the manipulation, quality control and presentation of hydrometric data. LAPLINK and BROOKLYN BRIDGE were three examples of communications software mentioned by Frank for transferring data between computer on site. A compiler enables the Hydrologist to tailor software for each project and ensures that he is self-sufficient.

The World Meteorological Organisations package CLICOM and the Institute of Hydrology package HYDATA were mentioned by Frank as two examples of databases for quality control, processing and presentation.

Frank then went on to demonstrate the use of spreadsheet packages as input shells for programs written in languages such as FORTRAN. The spreadsheet provides an interactive environment for data input and output through the use of macros and a tailored menu structure.

The Institute's program for flood

frequency analysis HYFAP was demonstrated. The operator uses interactive graphic screens to input data, select distribution type and fitting method and to display the results, providing a tool that no Hydrologist going overseas can do without.

Whatever rainfall-runoff model favoured by the Hydrologist, Frank presented the Institute's MIMIC package as an invaluable tool. The package, developed in response to the demands of numerous projects, provides a graphical environment for running any rainfall-runoff model. Model parameters can be changed manually or optimised using the Rosenbrock algorithm, goodness-of-fit statistics are calculated and any period of the simulation can be presented graphically.

Howard Wheater commenced the questioning asking both of our castaways what computer they would take. Both agreed that at least a 386 was required with lots of RAM and as large a hard disk as possible. Howard then asked how much effort was involved in developing the graphical side of the packages presented. Robin answered that all the graphics presented had been developed by specialist programmers, the Nile program for example had taken nine months to develop. Frank said that the Institute of Hydrology worked in the same way having a specialist computer department to provide programming inputs.

David MacDonald admitted to a certain amount of amusement that both castaways had chosen luxury cruises where excess baggage was unlimited! What would they consider to be the absolute minimum required for survival? Both settled for a word processor, spreadsheet and compiler, however, Robin admitted that he would cheat by smuggling in a portable modem.

Peter Wiley asked about backwater analysis packages. Frank recommends HEC2 as a general package, while Robin would use Mott MacDonald's HYDRO on the luxury cruise, and would revert to the use of a spreadsheet on the economy trip.

Joel Goldenfum questioned the wisdom of allowing the client to play with the operation of a project by computer. Frank said that often the client was not confident to take decisions and preferred to pass the responsibility to the Consultant. In addition, allowing the client to play with the system emphasizes the complexities of the system. Robin agreed and said that it was often necessary for the consultant to return and aid the client with decisions.

Peter Olmsted queried how often the castaways found that they were stranded for longer than originally planned. Robin recognised this as a real danger, but provided that the problem was initially well-defined and that the client understood the nature of the problem, prolonged stays were avoided.

Richard Croft concluded the questioning by asking the Castaways what text book they would take along. Frank confided that he rarely looks at a text book because he seldom finds anything useful in them! However, on reflection he recommends V.T. Chow's Handbook of Applied Hydrology. Robin agreed with Frank's choice, but would also take a good statistics book on the luxury cruise.

The meeting was closed by Howard Wheater, who thanked both our Castaways for giving entertaining and informative talks.

T J Jolly

The President's Piece

AGM

The AGM in Sheffield was very well attended. Thanks principally to **James Bathurst**'s excellent organising of the 'carrot' meeting on impacts of land use change, we raised a goodly crop of members to listen to the reports from the officers and to applaud newly-elected committee members **Susan Walker** (President Elect), **Richard Harpin** (Hon Sec.), **Tim Wyatt** and **Kevin Tilford** (Ordinary Members). The departing Hon Secretary (**Chris Collier**) presented his report and took the minutes of the meeting which, with his usual efficiency, he has worked up for publication in this issue. Chris has been an excellent Secretary in every respect and made many valuable contributions to the smooth running of the Society during his term of office. Fortunately, we have not lost his services entirely as he is continuing to serve on the Papers sub-committee for the Cardiff Symposium.

Ties - Part 1

After my appeal for feedback about the merits of us having a BHS tie, I was overwhelmed by the response from a member. At the AGM, however, there seemed to be widespread support for the idea so we are going ahead (there is a notice on p. 13 about the design competition).

Ties - part 2

Reciprocal membership arrangements have been confirmed with Canada, South Africa and Russia. We also have good working relationships with the Nordic hydrologists, to be carried forward by **Jim McCulloch**, Chairman of our International Liaison sub-committee. Negotiations with Societies in other countries tend to be protracted: like us they are mostly run by volunteers in post for a relatively short time. However, we continue to encourage contacts and I promise to issue a Handbook notice which may be of interest to members contemplating trips abroad.

Guaging wier spells trouble for would-be mice

Having agreed to be a specialist reviewer in hydrology for the Institution of Civil Engineers, I am still waiting to test my assessment skills on a suitably specialised candidate. However, I have been introduced to the procedure by acting as the assistant (or 'cross-matched') reviewer for a number of 'normal' candidates.

It has been interesting to observe the determined efforts being made by the Institution to maintain standards of literacy as well as technical knowledge and other professional skills. The Chartered Professional Review (CPR) procedure culminates in a two-part assessment on one day. In the morning, the candidate has an interview with the two reviewers where (s)he presents a Project Report and answers questions about training and experience: this should not be a problem for the well-prepared. In the afternoon, two essays (90 minutes each) are to be written: one on a technical subject chosen in the light of the candidate's own experience, the other on a subject chosen by the reviewers from a fixed, published list of topics concerned with the broader requirements of being a Chartered Engineer.

It is in the marking of the essays that the reviewers are able to influence standards of 'good written English' and candidates should be in no doubt that this duty is taken very seriously. In my (very limited) experience, candidates who were quite acceptable at interview were failed (or nearly so) purely because of poor essay writing. The judgements are one third on content, one third on grammar and syntax, one third on clarity and presentation. Each aspect is marked on a scale of A to D. Two grade Cs ('unsatisfactory') in either essay is an automatic fail. If the reviewer has to struggle with the handwriting *and* there are too many spelling mistakes or grammatical errors then it's curtains. Of course there is scope for some reviewers to be somewhat more demanding than others but there are checks to prevent excesses of severity or leniency.

Of the various criteria, spelling is unarguably (well, almost) objective. All that is required is that the marking reviewer *does* know the right spelling. Of course, a dictionary is useful, something denied to the candidates. So, would be MICE, be warned! Get your favourite spelling mistakes sorted out in good time. Don't make it easy for your reviewer to leap on those sound-alikes which afflict the lazy *hear* and *their*. And please, BHS members, although my reviewing colleagues would have scorned sentences beginning with a preposition or containing unorthodox punctuation - remember that as long as we silly British continue to think that a 'u' in 'gaging' is necessary, it should go after the 'a'. Did you know that over 50% of the population put it first?

My own favourite mistake was 'data'. I learned that it was a plural (of 'datum') rather late in life (I failed Latin 'O' level with a record low score of 8% - the scars still have not healed) and that to say 'the data was analysed' betrays one's plebeian origins! I used to be sure about 'independent/ant' and 'stationery/ary' and 'supersede(cede)', but now all I can sometimes remember is that these words need care, and are not spelt as you might first think. Then, because I have been spelling them right for years, I begin to spell them wrongly again. Is there a medical term for this?

AGM date change

The committee has decided to bring forward the timing of the AGM within the BHS calendar. Henceforth, it will be held in September. In alternate years it will therefore coincide with the national Symposium. The main reason for changing was to enable proposals for changes in subscription structure to be put to the meeting before they take effect (from October 1st) rather than (as in the past) being announced as a *fait accompli*. The acceptance or otherwise of the Treasurer's report will henceforth enable the membership to endorse/reject any such proposals. Although, given that the Treasurer presents a cogent argument, endorsement should be a formality, the committee believed that it was important to uphold the principle of consultation on this matter.

Enhanced membership directory listing

Accompanying this issue of *Circulation* you will find a form requesting extra personal information for inclusion in the next (May '93) issue of the Membership listing which is now a loose-leaf entry in the Member's Handbook. I do hope you will take time to complete and return the form and thereby make the new listing as complete as possible. The extent and type of extra information requested reflects members' wishes, as expressed in the questionnaire reported by **Rod Hawnt** in *Circulation* 35.

Some more NERC research grants in hydrology

Cold regions slope instability modelling (Prof MG Anderson, Bristol)

Monitoring & modelling bedload transport and channel change in braided streams (Dr KS Richards, Cambridge)

Water storage, drainage evolution and water quality in alpine glacial environments (Dr MJ Sharp, Cambridge/Southampton)

GIS & distributed hydrological models (Dr Keith Beven, Lancaster)

The effects of vegetation cover and type on the evapotranspiration from semi-arid catchments in southern Spain (Dr LD Incoll, Leeds)

Mapping natural hazards with spatial modelling systems (Dr G Wadge, Reading)

Competition!

Those who were at the AGM will know that our current President has a penchant for classy ties and thinks its time BHS had one. We discussed this idea further at the last Committee meeting and agreed to hold a competition among the membership to find the best design.

BHS members are invited to submit sketches incorporating the society's logo that would be suitable for use on a Members' tie and on a scarf or brooch. ['*What about T-shirts?' said your Editor*]. Whether we also need to have 'British Hydrological Society' or 'BHS' as well as part of the design we leave to entrants to decide.

The closing date for submissions is **31 March 1993,** in time for us to look at all your ideas at the next Committee meeting. A prize of book tokens worth £30.00 will go to the lucky winner.

New Members

We welcome the following members to the Society. The membership stands at 639*.
**but not all of these have paid their subs!*

Alden, J.E.. ..... South Glamorgan
Arthur, D.J.W. ..... Student, Dept. Civil Engineering, Imperial College
Austin. B. ..... University of Salford
Bell, J. ..... Dept of Geography, Sheffield University
Burleigh, J. ..... MSc student, Imperial College
Clare, A.F. ..... MSc student, Imperial College
Collinson, P. ..... Macclesfield, Cheshire
Croft, R.G. ..... Dept of Civil Engineering, Imperial College
Cromey, C.J ..... Edgbaston, Birmingham
Davis, R.J. ..... MSc student, University of Birmingham
Douglas, G.S. ..... Lewes, East Sussex
Dunsmore, S.J. ..... Reading, Berks
Evans, B.W. ..... Bishops Stortford, Herts
Fisher, C.R. ..... Walsall, West Midlands
Gatt, K. ..... MSc student, Imperial College
Griffin, J.H. ..... Institute of Hydrology, Wallingford
Hawker, J.R. ..... Birmingham
Jackson, M.J. ..... National Rivers Authority/Severn-Trent, Solihull
Leeson, M.J. ..... London W5
Leftley, D.C. ..... Isleworth, Middx.
Lewin, V.H. ..... Littlemoor, Oxfordshire
Linnett, J.O. ..... Hitchin, Hertfordshire
Lubrina, Y. ..... MSc student, Imperial College
Olmsted, P.C. ..... MSc student, Imperial College
Osborne, N.F. ..... Peterborough
Pratt, M. ..... Halifax, West Yorkshire
Preston, P. ..... MSc student, Imperial College
Ramwell, C.T. ..... Dept. of Geography, Sheffield University
Ratcliffe, J. ..... Huddersfield, West Yorkshire
Sanders, J.A.E. ..... East Grinstead, West Sussex
Silgram, M. ..... Dept. of Civil Engineering, Imperial College
Smith, T.M. ..... Mott MacDonald Group, Cambridge
Storey, B.J. ..... Northwich, Cheshire
Towers, S. Y. ..... Solihull, West Midlands
Warburton, J. ..... Dept. of Geography, Leicester University
Wardlaw, R.B. ..... Dept. of Civil Engineering, Edinburgh University

Minutes of the 9th Annual General Meeting of the British Hydrological Society

Present: **Dr Mike Lowing, President**
Tony Lewis, Honorary Treasurer
40 other members

Apologies

Apologies were received from Frank Law, Allan Lambert, Prof Des Walling, Dr Richard Harpin, Dr Graeme Herbertson, Dr Howard Oliver and Andy Bunch.

1. President's Introduction

The President welcomed those attending the AGM and noted that 1992 had been a quiet year of consolidation. The Committee were trying to identify exactly how many members the Society had, and were investigating why some members were tending to leave after a short time. The membership questionnaire had been analysed by Rod Hawnt and the results were providing useful information on the size and range that future meetings should embrace.

The Members hand-book had been issued during the year. Following suggestions by one or two members, the Committee would consider further additions such as the main interest areas of members. The aim was to provide a really useful contact guide.

The concept of reciprocal membership with other national and international societies had been implemented and had been taken up by three of four such societies. This would provide the membership with points of contact overseas.

Work had begun to prepare a plan for the Society. It had been noted that the BHS was now almost ten years old, and it was perhaps opportune to consider the future direction. The Royal Meteorological Society had recently completed such an exercise, and their framework would be used as a guide.

Dr Lowing mentioned the possibility of a BHS tie: those present encouraged him to consider the matter further.

The BHS prize was awarded to the best paper at the BHS Symposium, and during the intervening year between Symposia to the best contribution to *Circulation* in the preceding 25 months. Hence the 1992 prize had been awarded to Dr James Bathurst for his articles in *Circulation*. In accepting the prize Dr Bathurst expressed surprise and pleasure that his written work had been useful. He intended to donate half of the prize money to a hardship fund for the 3rd BHS Postgraduate Symposium which he was organising in April 1993 at Lancaster. The other half would help him to replenish his library.

2. Minutes of the 8th AGM held at the ICE, London, 2 December 1991

The minutes of the 8th AGM had been published in *Circulation 33*. There being no discussion of the minutes, Dr Pereira proposed their acceptance. This was seconded by Dr Sue Walker and the minutes were duly approved.

3. Report of the Honorary Secretary

The full report of the Honorary Secretary had been published in *Circulation 36*; he therefore only highlighted particular points. The membership stood at 586: considerable effort had been made by the Committee to try to identify the true number. It appeared that BHS had reached a membership plateau, gaining roughly as many members as it lost each year. Everyone in the Society was urged to encourage all those involved in hydrology to join.

The Committee had noted from Rod Hawnt's analysis of the membership questionnaire that 14-20% of the membership is under 30 years of age, and steps had been taken to ensure that this age group would be catered for in the activities of the Society (Agenda item 6).

A range of excellent meetings had been organised during 1992. The Drought Workshop at Loughborough was noted particularly as this was a precursor to the publication of BHS Occasional Paper No 3.

The profile of the BHS had been raised by their contribution to the Government on the debate concerning the proposed Environment Agency. The Honorary Secretary expressed the hope that the Society would continue to contribute in this way to nationally important hydrological matters.

The BHS Plan for the Future should provide a framework within which the Society could go forward during the next decade. However a more immediate goal was to organise a successful 4th National Hydrology Symposium. This would take place in Cardiff in September 1993 (*see back page*).

The Honorary Secretary concluded his report by thanking the Presidents under whom he had served, first as a committee member and then as Honorary Secretary. These were Professor Peter Wolf, Allan Lambert and Dr Mike Lowing. He also thanked all the members of the Main Committee, and particularly Peter Bacos of the ICE who undertook much of the really hard work as Secretary. The President thanked Chris Collier for all his work as Honorary Secretary.

4. Report of the Honorary Treasurer

Tony Lewis, the Honorary Treasurer, presented the income and expenditure of the BHS for the year ended 30 September 1992 (*see also the Treasurer's formal report on the next page*). In summary, the figures were:

Income:

1992	*1991*
£12 914	£26 554*

* included £15 210 from the 3rd National Hydrology Symposium

Expenditure:

1992	*1991*
£9262	£18 176

Surplus for the year:

1992	*1991*
£3652	£8378

Tony Lewis reminded the AGM that the BHS membership numbers were now static. The Society's costs had unfortunately increased. The ICE now required 15% of the BHS subscription income and both postage and printing costs had increased. He therefore concluded that BHS Subscriptions must increase: with the agreement of the Main Committee they had been set for 1992/93 at £19 for full members and £9.50 for student and concessionary members.

He planned to use some of the reported surplus to invest up to £10,000 for the benefit of a range of Society activities. The actual amount was likely to be less than this as interest rates had fallen recently. He concluded by thanking Mary McBride of the ICE for all her help in managing the BHS finances.

Dr Peter Walsh was pleased that the direct debit arrangement for paying subscriptions would benefit the Society, but wondered whether ICE received interest on funds held on behalf of BHS. He was concerned with delays he had noticed in the collection of money via direct debits. Mr Lewis confirmed that BHS funds did attract interest, and he

would investigate delays in collecting monies via direct debit.

5. Report on Publications by the Editor of *Circulation*

Celia Kirby, the Editor of *Circulation*, reported that *Circulation* had continued to grow. During 1992 there had been two 16-page issues, one 18-page issue and the November issue had been 20 pages long. She thanked all contributors, and felt that a nice balance was being achieved between meeting reports and general news items. It had been agreed that each member of the Committee should contribute at least one article during their term of office.

The Main Committee had discussed how to improve attendance at meetings, and Mrs Kirby would be investigating the production of a poster which could be updated every few months or so. This poster would be distributed to all the main institutes, universities etc.

The Membership Directory had been produced, but Mrs Kirby had noted that the previous directory issued some years ago had contained other information. She intended to investigate the preparation of information on postgraduate courses, hydrology in government, international hydrology, availability of data and libraries holding significant hydrological publications. Finally, it was noted that BHS Occasional Paper No 3 would be published soon. She thanked John Griffin of the Institute of Hydrology for all his work in the production of *Circulation* and other publications.

Dr Lowing noted that support for the Society was two-pronged, from the ICE and from IH. Thanks were due to IH without whose support the Society could not function fully.

6. Changes to Membership of the BHS Main Committee 1991/92

The President recalled that Dr Richard Harpin and David Boorman were retiring from the Committee. They were thanked for all their work. Chris Collier had come to the end of his term as Honorary Secretary and he would be replaced by Dr Richard Harpin who was the only nominee for the post. The two new Committee members would be Kevin Tilford and Tim Wyatt. In addition, Jennifer Taylor or the NRA South West region would be invited to attend the Main Committee with the specific responsibility of looking after the interests of the younger members.

Finally, the President announced the result of the ballot for the post of President Elect. There had been three candidates and Dr Susan Walker of the NRA North West Region had been successful. She would take up this post with immediate effect.

7. Any Other Business

The President and Jim Blackie urged the membership to contribute papers for the 4th National Hydrology Symposium. Although the official deadline had passed it was still not too late. There being no other items, the meeting was closed.

C G Collier
Honorary Secretary

Annual Report of the Honorary Treasurer 1991/92

The 1991/92 financial year ended on the 30th September, with a balance in the BHS account of £15 823, compared to £12 171 last year. This represents a surplus on last year's operations of £3652 compared to a budgeted surplus of £1650.

It is difficult to ascribe any one reason to this exceedingly good outcome. In general, memberships levels rose slightly to 596 "active" paid-up members along with significant additional income from publications and deposit interest, whilst costs have been tightly controlled as far as possible. In 1991/92 BHS has thrived with a pro-active membership at national and regional levels, including a spirited revival of the related Pennines Group (*see page 16 - Ed.*), and with matters on a sound financial footing.

The subscription level for 1992/93 has been set at £19 for full members and £9.50 for students and concessionary members. In setting these levels the committee has had to give due regard to significant rises in costs of printing and postage plus an increase in the Society's contribution to ICE which has not changed for nine years. All affiliated societies are facing increased contributions to ICE — which for BHS will be 15% of our subscription income. It is felt that this represents good value for money in terms of the service provided.

In setting the subscription levels the committee also felt that the accumulated balance of £15 823 should be used to further the aims of BHS and not to underwrite the subscription.

To this end, the committee are considering investing up to £10 000 in an "investment" account which will generate income. This income would be used to fund new initiatives which encourage the subject of Hydrology, particularly within the younger membership. The exact details are still being considered and it is hoped will be finalized early in the New Year.

In conclusion, I would like to thank the Chairman and committee for their patience and forbearance whilst discussing matters financial rather than hydrological, and Mary McBride and her colleagues in the ICE Finance Office without whom the Treasurer's task would be impossible.

A. M. Lewis
Hon. Treasurer, BHS

Southern Science goes North

Southern Science, the environmental services company based in Worthing, is setting up a northern office in Warrington, to be headed by **Rick Brassington**, former Managing Director of Simon Hydrotechnica.

Rick is a Chartered Civil Engineer and Chartered Geologist who has written books and papers on groundwater and won the Institution of Geologists' Aberconway Medal in 1987. He was formerly Principal Hydrogeologist with the North West Water Authority and then Regional Water Resources Manager for the NRA North West Region.

All Southern Science's services — analysis of soils, contaminated land, effluents, liquids and gases; consultancy in hydrology, environmental impact assessment, modelling, water and waste treatment — will be available through the new northern office. For details ring Rick Brassington on 0925 766754.

Education and Training

The position regarding routes to chartered status for BHS members is again becoming fluid. Various changes within IWEM and the Royal Meteorological Society suggests that two new routs to chartered status may open up.

IWEM will be balloting members in the next couple of months with a view to obtaining a Royal Charter. If the move is successful, Corporate Members of IWEM will be able to call themselves Chartered Water and Environmental Managers. This means that the existing route to chartered status via the joint IWEM/ICE committee and the Engineering Council will become obsolete.

Similarly, the Royal Meteorological Society are balloting their members about implementing their Accreditation Scheme which will include chartered status.

The Education and Training Subcommittee have been in discussion with both organisations and it appears that both these new routes will offer a less traumatic route to chartered status than either the ICE or the existing IWEM route.

It is expected that, if the ballots are successful, the new routes will be available later in 1993. Once the position becomes clearer, the E&T Subcommittee will given an update in a future issue of *Circulation*.

The Pennines Hydrological Group

Following a highly successful technical meeting and AGM in October, the PHG seems to be rising from the ashes. At the October meeting the future of the Group was discussed and the general feeling was that PHG should become a Regional Section of BHS — the Pennines Section of the BHS.

The ICE Local Associations and the local IWEM Branches are supportive of this move and the feeling of the meeting was that the new affiliation should be ratified at the next AGM, to be held in May. Meanwhile, a caretaker committee (headed by Keith Beven, Chairman, Katherine Howard, Secretary, and John Ratcliffe, Treasurer) was charged with organising a programme of meetings and revising the PHG Constitution to cater for the move from ICE to BHS so that this can be put to the membership at the AGM.

A subsequent committee meeting has resulted in the following draft programme:

March 1993	Half-day meeting, probably at Lancaster, on flood topics
May 1993	AGM and meeting on leakage detection/network analysis. Venue: Huddersfield area.
Sept 1993	Half-day meeting, proposed visit to Horsforth modelling lab.
Nov 1993	Half-day meeting on river intake protection. Venue: NRA Newcastle
Jan/Feb 1994	Half-day meeting on groundwater. Venue: Warrington.

International Hydrology

The WMO's Commission for Hydrology (CHy) recently held its ninth meeting in Geneva. The Commission meets every four years and operates as a mini-UN with delegations from about 60 countries attending the meeting in early January. Broadly, its remit is to foster international hydrology at the governmental level.

The UK fielded one of the larger delegations at CHy-9 thus permitting a full involvement ranging from the promotion of important international causes to editorial assistance. **Brian Wilkinson** headed the team, and was assisted by **Peter Walsh, Allan Lambert, Chris Collier, Ian Calder** and **Max Beran**.

CHy sets the agenda for the WMO Hydrology and Water Resources Programme for the following four years. One of the most important actions was to set up three Working Groups and 18 Rapporteurships.

Chris Collier was designated Rapporteur on Precipitation Estimation and Forecasting within the Working Group on Hydrological Forecasting and Applications for Water Management.

Max Beran became chairman of the Working Group on Operational Hydrology, Climate and the Environment. Its remit includes GEWEX, impacts on water resources of climate and environmental change, and environmental sustainability and water use. Max will also serve on the Advisory Working Group which provides the link between the secretariat in WMO and the working groups and regional associations, and also acts as the Steering Committee for HOMS.

Karl Hofius from Germany replaced Odon Starosolski of Hungary as the President of the Commission.

BOOKS

Regional hydrology

David Archer. *Land of Singing Waters,* Spredden Press, 1992, 217pp Hardback £17.95 ISBN 1 871739 27 6, Paperback £13.95 ISBN 1 871739 28 4.

This delightful book on the Rivers and Great Floods of Northumbria is a real treat - beautiful pictures (many in colour) and fascinating facts, and a joy to read. So much so, that your Editor having pinched it from the Reviews Editor before he had time to send it out, now feels that it merits a more of a hydrological peer review than she could give it. Accordingly, there will be more on this book in the next issue.

Meanwhile, for those who would like a copy on the basis of this recommendation alone, you will be pleased to learn that they are available direct from David Archer at NRA Northumbrian Region with the added incentive of £1.00 off for BHS members.

Celia Kirby

Damned lies?

The UK Environment Department of the Environment, Government Statistical Service, HMSO, 1992, 257 pp, ISBN 0 11 752420 4 Price £14.95.

I opened this volume with some trepidation. After all, you do not expect to have much fun reviewing 250 pages of facts and figures. However, right from the start I was struck by the high quality of production, the very nice design work and the readability of the text.

This is a book designed to 'inform public debate' and is for consumption by that mythical creature, the intelligent lay person. It is, therefore, primarily an exercise in the art of communication. The editorial team had the difficult task of selecting the topics to be covered and the level of detail. Inevitably, to the individual reviewer with particular knowledge of one area, there are gaps in some places and too much irrelevant detail in others. But the team was striving for balance and they have achieved it remarkably well.

The report has seventeen chapters. The first is a general introduction to the British climate. The next thirteen chapters cover individual environmental facets: air quality and pollution; the global atmosphere; soil; land use and cover; fresh water resources, fresh water quality and pollution; the marine environment; coastal erosion and flooding; wildlife; waste and recycling; noise; radioactivity; the environment and public health. The final three chapters deal with aspects of environmental management: pressures on the environment (for food, transport, energy); public attitudes (includes a fascinating table showing the growth - typically tenfold - in membership of the voluntary environmental organisations over the period 1971-90); and environmental expenditure.

In a review for *Circulation* it is appropriate to focus on the chapters on climate and on inland water resources. The (basic UK) climate chapter is quite brief but to the point: it covers the bare bones of mean temperature and rainfall variations with some cursory glance at wind and fog regimes. It looks almost as if the chapter was tacked on as an afterthought; it is the only one not to begin with a useful bullet listed summary. It pointedly omits any mention of climate change which is covered adequately in the separate chapter on global atmosphere. This latter is a really useful chapter to which I shall in future turn first when seeking to give a responsible answer to the 'so, do you think there's anything in this climate change thing then?' question.

The chapter on fresh water resources starts with an assertion that 'average annual replenishment of fresh water resources in the UK from normal rainfall is estimated to be around 120,000 gigalitres surface water resources and 9,800 gigalitres from main groundwater resources'. Having thought about it for a bit and worked out what a gigalitre is, I think I know what they mean but I doubt that the figures will mean much to the average reader. This is a minor quibble though; the rest of the chapter is - given the need to simplify - a fair shot at explaining the complexities of water supply and demand.

Of course there are some minor misprints (such as the curious suggestion that evapotranspiration takes place through 'spores' - p.2) but, on the whole, the contents look as if they have been checked out by specialists.

There are 230 charts and 60 tables in the book. Many of the 'charts' are maps of the UK (or GB, or England and Wales, or England - depending on availability of data and organisation providing them) and these contain an impressive amount of easily assimilated information.

After each chapter there is a useful list of references and suggestions for further reading. Obviously these could be enlarged but there is usually enough to enable anyone with a serious interest in a particular topic to be pointed in the right direction.

You can tell they are serious in Whitehall about bringing business practices into Government when they price a book of statistics at £14.95 rather than £15. I suppose the price is right for the intended market but I value the contents more highly than that and so can thoroughly recommend the book as a invaluable first point of reference on anything and everything to do with environmental data.

The book is rendered even better value by the offer to supply a computer disk containing information on which many of the charts and tables are based. The data may be obtained in ASCII form, in Lotus 1-2-3 format or, astonishingly, in some 'other' format as may be specified by the reader.

Mike Lowing
Brightwell Baldwin

Australian hydrology

International hydrology & water resources symposium 1991: Challenges for sustainable development: preprints, The Institution of Engineers, Australia, National Conference Publication 91/22, 1991, 953p + abstracts, ISBN 0-85825-540-5.

Avid readers of *Circulation* (no 35 p12) will have seen Mike Lowing's account of the international hydrology and water resources symposium staged in Perth, Western Australia on 2-4 October 1991. The main sponsor was The National Committee on Water Engineering of the Institution of Engineers, Australia, with UNESCO, WMO and IAHS co-sponsoring. (The major financial sponsor was the Water Authority of Western Australia). Mike concentrated his comments on the conference organization and the social activities, but felt that the scientific proceedings were of a standard deserving of inclusion in an international indexing system (GeoArchive) and separate review. He volunteered me for these tasks....

The printed proceedings, or in fact the preprints which appeared in July 1991, comprise three volumes totalling over 1000 pages when the paper abstracts and indexes are included. These volumes are well prepared, and although no standard style has been followed for the papers, all the text and diagrams are clear and provide a pleasing read. This was the 20th hydrology symposium held under the auspices of the Institution of Engineers, but the first dubbed 'international' to be held in Australia. That 78% of the 149 papers and 85% of the 27 poster papers have Australian first authors in fact meant that the event had a strong Australian flavour. On the international league table of authors, the USA with just 10% and Japan only 2% followed the host nation: were the BHS members there only to do strange things with ping-pong balls?

I suspect that the theme of the conference, 'Challenges for sustainable development' was chosen largely for its

media appeal, and in reality the papers focused on the planning and management of virtually all aspects of water resources. Papers were presented in sessions under various (26 different) subject headings: only 8 papers came under the heading 'planning for a sustainable environment'. The most popular headings were: 'Water resources planning and management' (20 papers), 'Salinity and land degradation' (11), 'Groundwater contamination' (9), 'Groundwater' (9), 'Public participation' (8) and 'Model calibration and software (8).

In a short review it is impossible to go into the details of individual papers, so I will just mention briefly a few points which appealed to me and leave readers to study the papers in their fields of interest, be they complex mathematical modelling, viewing water resources as a part of a larger socio-biophysical system, or measuring rain angle.

The problems of salinity have obviously assumed major importance in parts of Australia: it is a recurring theme appearing in a number of papers in addition to the 11 referred to above which specifically deal with the topic. There is a consensus about the causes and constructive ideas are proposed for dealing with it. An area of endeavour new to me was the structured involvement of the public in water resources decision making: several examples of successful use of this technique are given where the likely environmental impacts of different scenarios have been constructively explored.

My favourite paper title is 'The iffiness of the Imminent Failure Flood', the pun reflecting the need for re-appraisal of (Australian) dam safety practices and the methods for design flood and probable maximum rainfall estimation.

The paper which gave me the most satisfaction is 'Hydrological instrumentation: a review of recent developments in Australia' by A C Falkland *et al.* In this, the need to apply the principles of total quality management and quality assurance to hydrological instrumentation management is presented. How I wished I had seen a reference to this paper during literature searches prior to making a similar recommendation to the NRA in a review of their hydrometric data processing. I would have felt much more comfortable about advancing what I naively thought was a novel idea had I realised that it had been in use by antipodean colleagues for some years!

Overall many interesting and stimulating papers, even though the Australian perspective was dominant. I can hardly wait to get my hands on the preprints for the 21st symposium!

Roger Templeman
Garsdale, Cumbria

News from Members

Jim Shuttleworth, Head of the Hydrological Processes Division at IH, has not only left the Wallingford campus but also quit the shores of the UK to take up a new post as Professor of Hydrometeorology at the University of Arizona in Tucson, USA.

Jim spent 18 years at IH, building up a team of like-minded souls all trying to add to our knowledge of the evaporation part of the hydrological cycle. Jewels in their crown include the ABRACOS project in Amazonia, and contributions to GEWEX through HAPEX in Niger, EFEDA in Spain and other international collaboration studies. These projects will all continue, of course, and doubtless go from strength to strength, but Jim's special brand of humour and good-nature will be much missed.

On his retirement from the Department of the Environment last year **David Rodda** has been appointed as Team Leader of the Programme co-ordination Unit of the Environment Programme of the Danube River Basin. The team, which is six strong, is currently housed in the offices of DGXI of the Commission of the European Communities at Delta, near the Free University of Brussels.

BHS members win British Computer Society medals



Bob Moore from IH (left) and Margaret Cottingham of NRA Yorkshire Region (right), together with Peter Bird from Logica, receiving the British Computer Society's Information Technology Award from HRH The Duke of Kent on 11 December 1992 at the Waldorf Hotel, London.

The River Flow Forecasting System (RFFS) has been developed by Logica and IH on behalf of the NRA to provide forecasts of river flows and levels for the whole of Yorkshire, using data collected from over 100 sites throughout the region's river network and the UK Weather Radar Network. With forecasts generated for a few hours up to days ahead, the system is an integral part of the flood warning and day-today management of Yorkshire's rivers.

The RFFS was among 11 award winners this year in the British Computer Society's scheme designed to encourage the best in UK information technology and its applications.

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FORTHCOMING EVENTS

Fourth BHS National Hydrology Symposium

Cardiff 13-16 September 1993

The **venue** is the University School of Engineering, close to the centre of Cardiff, the historic yet lively capital of Wales. Accommodation in a University Hall will be within easy walking distance of the venue. For those with more luxurious tastes and expense accounts, accommodation at special conference rates will be available in a nearby four-star hotel. Lunch, morning and evening meals will be served in the School and there will be a bar in the evenings.

The **outline programme** is:

Monday 13 September Registration, exhibitions, **BHS AGM**, sherry reception

Tuesday 14 September Formal opening, technical sessions, exhibition, **Welsh Hydrological Group AGM**, Mediaeval Banquet in Cardiff Castle (optional)

Wednesday 15 September Technical sessions, exhibition, **Conference Dinner** (guest speakers, hydrological games)

Thursday 16 September Technical sessions till lunchtime, Field visit to Cardiff Bay Development.

We are aiming to keep **costs** as low as possible. The basic cost for the full period will be **£155.** This will include Hall accommodation, meals and a pre-printed volume of the papers. Options for attendance on individual days will also be available. A full programme, including registration forms and cost options, will be circulated as soon as the details of the technical sessions have been finalised.

The response to the calls for papers was very gratifying. The Technical Sub-Committee had nearly 50 abstracts to consider when they met in late January. Authors will be hearing from them during February. A large proportion of the abstracts received dealt with aspects of water resources assessment and management: this will be reflected in the final shape of the technical programme. A wide range of other topics was covered, including interesting new developments in modelling and in low flow estimation, new studies of extreme events and a range of descriptive papers on applied hydrology in the UK and overseas. From these we should be able to assemble a programme with something to interest everyone.

The local organiser, **Rob Drayton**, is keen to hear as soon as possible from those interested in booking space in the exhibition area for instrument, software or poster displays. He can be contacted at: Wallace Evans Ltd, Plymouth House, Cardiff CF6 2YF. Tel: *0222 704321;* Fax: *0222 709793.*

Other enquiries should be addressed to **Jim Blackie** at the Institute of Hydrology, Wallingford OX10 8BB. Tel: *0491 38800;* Fax: *0491 32256*

Course

ORGANIC POLLUTION OF GROUNDWATER
University of Birmingham
19-22 April 1993

A four-day course is offered jointly by the Universities of Birmingham, Waterloo (Ontario), Queens (Ontario), and Tübingen (Germany). The course will be held at Birmingham University. The non-residential fee is £550.

For further details, contact Vanessa Chesterton, School of Earth Sciences, The University of Birmingham, Birmingham, B15 2TT, UK, *Tel: 021 414 6751.*

Diary

3rd March 1993
BHS Southern Section Meeting
"Hydrology of the coastal zone"
Venue: Imperial College, London
Time: 5.30 p.m. (tea at 5 p.m.)
Contact: Dr Howard Wheater, Dept of Civil Engineering, Imperial College, London, SW7 2BU. *(Tel. 071 589 5111 ext. 4736; Fax: 071 823 8525)*

3rd March 1993
BHS Midlands Section Meeting / IWEM (East Midlands Section)
"The Derbyshire Derwent"
Venue: Loughborough University
Contact: Paul Webster, Dept of Civil Engineering, University of Birmingham, Birmingham, B15 2TT. *(Tel: 021 414 5055, Fax: 021 414 3675)*

12th March 1993
Scottish Hydrological Group
"Snowmelt runoff modelling" — Dr A Bennett, Clyde RPB
Venue: Strathclyde University
Time: 6.30 p.m. (tea at 6 p.m.)
Contact: Dr D J Gilvear, Dept of Environ. Science, Stirling University, FK9 4LA *(Tel: 0786 731711; Fax 0786 67843)*

6th-8th April 1993
Third BHS Postgraduate Symposium
Venue: University of Lancaster
Contact: Dr James Bathurst, University of Newcastle upon Tyne *(Tel: 091 222 6333, Fax: 091 222 6669)*

14 April 1993
Welsh Hydrological Group
"HEP in Wales — Case studies"
Venue: Swansea
Contact: Linda Aucott, NRA Wessex Region *(Tel: 0278 457333, Fax: 0278 662153)*

3rd-7th May 1993
EGS XVIII General Assembly
Venue: Wiesbaden, Germany
Contact: Professor P E O'Connell, University of Newcastle upon Tyne *(Tel: 091 222 6405, Fax: 091 222 6669)*

12th May 1993
BHS Southern Section/Royal Geographical Society
"Hydrology & Sustainable Development"
Venue: Royal Geographical Society
Contact: Dr Howard Wheater *(see above)*

Copy Deadline for Issue No. 38 8th April 1993

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