Irish Meteorological Society

Newsletter

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Contents:

President: J.A.Scott *Secretary: A.Kelly*

Hydrology, Ireland and Disaster Mitigation

by

J.E. Nash

Hydrology has always been a poor relation of meteorology. Even the title of the World Meteorological Organization does not indicate the association of that body with hydrology. In Ireland too, hydrology has acquired scant recognition. Ireland must be almost unique among developed countries in not having a specific national hydrological organization. Indeed, most developing countries have such a service. Yet Ireland has had for many years a considerable interest in hydrology.

The Shannon hydroelectric scheme was designed without the benefit of much hydrological data or analysis. Later hydroelectric schemes were designed by the ESB, with the benefit of at least some records of streamflow. However, it was not until about 1945, that the arterial drainage act provided the stimulus within the Office of Public Works for whatever hydrological analyses has since been undertaken.

When Irish rivers flood, they do so in a gentle, unobtrusive way, causing inconvenience certainly, some risk to livestock and property, disruption of traffic and damage to agriculture, but never a disaster as that term is understood in so many other countries. Much the same can be said about droughts. Yet the arterial drainage programme provided its own version of the classical challenges to the engineering hydrologist. The economic design of the works required, inter alia, a prior assessment of the frequency of occurrence of peak flood magnitudes. Some estimates of this could be obtained from the records of discharge and water level, which the hydrometric survey of the Office of Public Works established, and maintained from then onwards, but the remedial works themselves when undertaken would change the regimen of the rivers so that higher flood peaks must be designed for, than would otherwise be indicated. The assessment of this change in the regimen became the principal challenge and the determining influence in forming the character of Irish hydrology.

I would not like to give the impression, however, that there ever was an official response to that problem, or any official recognition of the role of hydrology in these early days. The credit, if credit there is, goes to individuals - O'Kelly, St. John, Farrell, Dooge, Lynn, Corish to name only some of those who were involved in the early days. These men created an awareness of hydrology within the Office of Public Works without official recognition, or support.

Some twelve years ago on my first visit to China, after a lecture to some couple of hundred Chinese hydrologists who could speak some English, I was asked "what is going on in hydrology in Ireland now?". I answered "very little" and explained that about a quarter of all Irish hydrologists were in China at that moment. This provoked an interest, mainly in what was the special attraction in China which brought so many people from the other side of the world, and where in China was all this happening? My hosts were amused when I explained that at the time there were probably only four or five persons in Ireland who would consent to be called hydrologists and I was therefore one quarter of the whole.

The Irish hydrological situation has not been untypical, only extreme. Hydrology has had to struggle for recognition in most countries. Canada is the only country I know of, where the term "hydrology" appears frequently in newspapers, implying that it is widely understood.

Even among hydrologists themselves there is no clear understanding of the appropriate place for hydrology in the world of science and technology. One American colleague has written "the niche for hydrology in the Pantheon of the sciences is vacant".

I have just returned from Paris where I attended a commemmorative meeting at UNESCO for the International Hydrological Decade, begun twenty five years ago. The President of the International Association of Hydrological Sciences presented a paper entitled:

"The Science of Hydrology: Where have we been: Where should we be going: What do hydrologists need to know"?

The title itself is very informative about the present state of hydrology. There is also an IAHS-UNESCO committee dealing with the problem of appropriate education for hydrologists. I happen to be the chairman of that committee and I can tell you that if hydrology is concerned with disasters that committee is right on line!

Despite the lack of a perceived identity, hydrology has become somewhat more fashionable in the past forty years. It now provides numerous interesting and not unrewarding careers to many who have committed themselves to it. In the past twenty five years, Great Britain has established an Institute of Hydrology with, I should think, in excess of one hundred staff. The World Meteorological Organization has expanded its interests to accommodate hydrology.

UNESCO supports hydrological studies and educational programmes, particularly for the developing world. The UNDP and FAO regularly call on hydrological expertise and in Ireland our government, as part of its Bilateral Aid Programme, has funded an M.Sc. Course and associated development of hydrological techniques at University College, Galway. In the meantime, my committee continues to squabble about whether hydrology belongs among the sciences or is merely a technology, and if a science what is its domain.

I think the truth is that hydrology grew in the engineering world, in response to the occurrence of actual problems in the area of water resources development. Attempts to solve these problems led to the identification of others and to the initiation of research into the existence of natural relationships between hydrological variables, usually integrated to the catchment scale. Perhaps because we engineers did not know enough physics, or perhaps because the complexity of the boundary conditions of our problems excluded the practicality of synthesizing these relationships from basic physical laws, we have had to have recourse to a more empirical method, as if hydrology were itself a basic science to be advanced by hypothesis formulation and testing within its own domain.

Experimentation on the catchment level is scarcely feasible, but observation is, and hydrologists have tended to seek for expressions of the relationships they needed in the records of rainfall, evaporation and discharge from natural catchments. *The seeking has become the method, and the relationships the principles of the "science" (if it is one) of hydrology.* The absence of an opportunity for experiment and the consequent necessity to rely on observations, has also lent a certain charm to applied hydrology. Problems are brought to one, only if they seem to be scientifically insoluble, and if a partial solution is to be found, it is usually obtained through the application of one's ingenuity in some unforeseen and certainly unprescribed, manner an analysis of the existing records. The records, not the problem, usually define the approach. I always tell students that there is an analogy between the work of the hydrologist and that of the detective. Both involve the exercise of an ingenuity which would not be required if more well defined methods existed.

There is of course a strong connection between hydrology and meteorology. The interface is in the area of rainfall and evaporation. Indeed, I think it is true to say, that until recently the hydrologist had the greater interest in these phenomena, though there were usually considered to lie within the domain of meteorology. This situation may have changed in recent years due to the interest of the meteorologist in atmospheric models to which evapotranspiration provides one of the more interesting inputs. No doubt, in time, the rainfall-runoff models which occupy such a large part of the attention of hydrologists, will become integrated with the atmospheric models of the meteorologist to the better understanding of the whole cycle.

Rainfall-runoff models, and models concerning the routing of floods through river networks constitute the hydrological bases of most flood forecasting systems. The main limitation on such models is our inability to predict the rainfall. The synthesis of the two kinds of models may also provide this. In the meantime, we hydrologists, are not without problems of our own.

It should be remembered that rainfall-runoff models and flood routing models are required not only to deal with spectacular disasters, but more prosaically to optimize the routine management of water resources on large rivers. Storages must be discharged in anticipation of incoming floods, or husbanded in anticipation of droughts.

A great deal of work has been undertaken, and some progress has been made in the development of such models in the past twenty years. This has been made possible mainly through the availability of computers. WMO has not been slow to appreciate the importance of this work and several years ago sponsored a large scale international study generally referred to as "The WMO Intercomparison of Conceptual Rainfall-Runoff Models". The owners of a set of models were invited, each to apply his own model to sets of data from several catchments scattered throughout the world. Each consenting owner was provided with concurrent data on rainfall, potential evaporation and discharge, for a period of some four years, and concurrent data of rainfall and potential evaporation, but not discharge, for a further period of two years. The models were to be calibrated in the four years "calibration period" and applied independently to compute the discharge hydrographs for the two years of the "verification period". Comparison of the actual and calculated discharge hydrographs was subsequently carried out by WMO itself.

In a lecture such as this there is no time to describe the interesting intricacies of this work, but I would like to tell you about one aspect of the results obtained, which I think is significant.

Some of the best results in the Intercomparison were obtained by the application of a model developed by the U.S. Army Corps of Engineers, known as the "SSARR Model". Applied to the data of the Sanaga catchment in Cameroon in West Africa, the model accounted for 89% of the variance of the discharge in the verification period. That is, the sums of squares of error in the predictions of the model amounted to only 11% of the sums of squares of difference from the mean of the calibration period applied to the hydrograph of discharge in the verification period - a very satisfactory result indeed. However, it seemed to some of us that it was unfair to judge the forecasts of a rainfall-runoff model by comparison with a forecast so unnecessarily primitive as the mean of the flow during the calibration period. Even without a model, one could certainly take account of the seasonal variation of the hydrograph, as manifest in the calibration period, and one could therefore issue a forecast that the flow on the 22nd March would be the mean of the flow observed, not throughout the calibration period, but the mean of recorded flows on that date only, among the years of the calibration period. Obviously it would be a more valid test of the model's efficiency to compare its forecasts with the best forecast which could be obtained without a model, viz., the seasonal forecast as defined.

I obtained a small grant from WMO to enable a student to work on this project for a little while and the results he obtained were as follows:

For the Sanaga catchment and the SSARR model:-

The initial variance of the flows in the verification period amounted to 0.232 units.

The variance left unaccounted for by the SSARR model amounted to 0.025 units, yielding a proportion of variance accounted for $R^2 = 0.89$.

The variance unaccounted for by the seasonal prediction alone (viz., the mean of the observed flows on corresponding previous dates) was 0.020 units corresponding to a variance accounted for by that primitive model, $R^2 = 0.91$.

The SSARR model was therefore slightly less efficient than the mere seasonal prediction (which we called "the Peasant's model"), or, judged against this standard, the efficiency of the SSARR model was negative.

The reason of course was that the SSARR model, which was an elaborate rainfall-runoff construction, did not, explicitly allow for the observed seasonality in the hydrograph of discharge from the Sanaga catchment. The Peasant's model however took account of nothing else.

The result was certainly startling, indicating as it did, that a peasant sitting by the Sanaga River, and observing the seasonality of its behaviour, could predict with greater accuracy than could the hydrologists equipped with one of the most elaborate modern tools of hydrological analysis, supplied with several years of daily data on rainfall and potential evaporation, and afforded the opportunity of calibrating their model with four years of concurrent rainfall runoff and potential evaporation data.

Without doubt, the initial work on catchment modelling tended to be somewhat undisciplined, unsystematic. Elaborate models of catchment operations were postulated and tested with data on areal rainfall potential evaporation and discharge. Parameters were optimized by a variety of techniques, but generally we failed to respond to the necessity for testing the hypotheses of our models, particularly in testing the dependence of the adequacy of the model on each of its component parts.

Over the last few years we, at University College Galway, have carried out an extensive study of rainfall-runoff modelling and flood routing. We have acquired data from many parts of the world and we have applied our models in a systematic, orderly fashion, developing and elaborating the model only when we are satisfied that the consequent improvement is significant. We have attempted to include observations on the seasonality of rivers where this is marked, and we have found generally that on some of the large rivers of the world considerable improvement on traditional forecasting methods can be obtained by attempting to model the relationship between departures from seasonal behaviour, in input and output data, rather than the relationship between the data themselves, thus combining the seasonal predictability with the conceptual model.

We have held workshops in Galway which were attended by experienced hydrologists from many parts of the world, who were brought to Ireland under the Bilateral Aid Programme, and spent some months in study with us, bringing with them data from their own countries, and participating in our researches. We have made some progress.

This work has been made possible by the far-sightedness of the Department of Foreign Affairs in making available to us funds from the Bilateral Aid Programme, for educational and development work in applied hydrology.

Over the past ten years we have also provided an M.Sc. course in hydrology and have received some two hundred students from all over the developing world, from China to Latin America and from India to Africa. These have studied with us for a year of instruction and subsequently carried out projects of research, to meet the university requirements for the award of the M.Sc. degree. A small number have stayed on to do further research towards the Ph.D. degree, but the majority have returned home to work in universities, or water resources organizations, in their own countries.

We have also helped in the development of a similar course at the University of Dar-es-Salaam. It is the intention that this course should as soon as possible be replaced in the control of the local staff.

In all this work we have been helped by the World Meteorological Organization and UNESCO in innumerable ways, including the provision of some fellowships for our participants. However our greatest obligation is to the Bilateral Aid Fund of the Department of Foreign Affairs, which through the vision of successive governments, has continued to provide funds for the exercise of these projects. My colleagues and I appreciate the confidence placed in us and we hope that the long term advantages to the third world deriving from our work will more than compensate for the necessity to forego the benefits which could be obtained in the shorter term by alternative uses of these funds.

SERVICE NEWS

Roche's Point Meteorological Station closed in February 1991 , ending a record of meteorological observations which started in 1873.

It's place in the 'weather reports from coastal stations' is being taken by the adjacent Roche's Point Lighthouse.
For the present, Donal O'Shaughnessy remains there to make one detailed observation per day, maintain climatological records and oversee the station.

Edward Tucker and Tony Cotter have both been transferred to Cork Airport and Noreen Kelly to H.Q.

Other staff moves of late have been as follows:

Martin Haran - from Clones to Malin Head
Willie O'Byrne - from Mullingar to Belmullet
Stephen O'Shea - from Cork to Birr
Pat O'Regan - from Kilkenny to Belmullet
Kevin O' Herlihy - from H.Q. to Casement Aerodrome
John Middleton - from Birr to Claremorris
Gerry Griffiths - from Dublin Airport to H.Q.
Gerry Dunne - from Dublin Airport to Rosslare
Jean Byrne - from Shannon Airport to C.A.F.O.

Irish Meteorological Society

Secretary's Report

The Society's first event after the A.G.M. in 1990 was a very enjoyable outing to the Mace Head Field Station and the Atmospheric Physics laboratory in Galway in May.

Our first **Annual Dinner** was held on January 26th in Dublin and was deemed a success by all who attended.

The committee met on three occasions: August 16th and November 23rd 1990, and March 19th 1991.
A decision was taken to introduce student membership rates of £6 and £4 (Dublin area / outside Dublin).

Five lectures were organised since the last A.G.M but unfortunately - and ironically - the weather caused the lecture on "Drought in the Sahara" to be cancelled.
The lectures which did go ahead were as follows:

"The Television-viewer's guide to the weather !" by Mr. John Doyle.
"Chaos" by Dr. Dave Fegan.
"Data Extraction from Europe's Meteorological Satellite" by Mr. Tom Sheridan.
"The Atmosphere of the Living Planet Earth" by Dr. Owen Wilson, to mark **World Meteorological Day**. This lecture was introduced by the Director of the Irish Meteorological Service, Mr. Declan Murphy.

Six Newsletters were issued, numbers 22-27 inclusive.

We are grateful to the **Irish Meteorological Service** for continuing to allow the Society the use of the facilities of the Service.

**** The **Annual Outing** this year is to Armagh Observatory and Planetarium on May 11th. Those interested in travelling should contact me as soon as posible.

I would like to thank the officers and members of the committee for their advice and assistance over the past year. Finally, my thanks to you, the members of the Society, for your continued support.

Aidan Kelly
Secretary
April 1991

Irish Meteorological Society

STATEMENT OF ACCOUNTS TO 31-DEC-1990

Income:

Membership (66x£8;44x£4)	£ 704.00
Subscriptions to Weather Magazine (15)	£ 234.15
One Day Meeting	£ 227.88
Ov/payment of SO	£ 44.00
Forward Payment of Subs.	£ 26.00
Interest on Savings Account	£ 5.95
Total Income	£1341.98

Expenditure

Stationary and Phonecalls	£ 33.80
Photocopier	£ 60.00
Postage	£ 28.54
Sterling Draft for Wx. Mags.	£ 234.10
Lectures Expenses	£ 320.77
AGM and One Day Meeting	£ 279.85
Sherry Reception	£ 51.10
Bank Charges C/A	£ 14.89
Refund fees to K Brevik	£ 8.00
Photo's (P Vardon)	£ 16.50
Misc. Stationary+Postage for A. Kelly	£ 82.63
Total Expenditure	£1130.28

Income vs Expenditure

Total Income	£1341.98
Total Expenditure	£1130.28
Increase in assets	£ 211.70

C/A Balance carried over from 1989	£ 141.41
S/A ,, ,, ,, ,, 1989	£ 263.99
Cash in hand ,, ,, ,, 1989	£ 78.67
Total assets from 1989	£ 484.01

Irish Meteorological Society

STATEMENT OF ACCOUNTS TO 31-DEC-1990
CONTINUED

C/A Balance at end of 1990	£ 85.96
S/A ,, ,, ,, ,, 1990	£ 645.94
Cash in hand at ,, ,, 1990	£ 50.00
Total assets at end of 1990	£ 781.90
Increase in assets from 1989 to 1990	£ 297.89

Compiled by: Sean McCarthy

Checked by:

ONE-DAY MEETING APRIL 27TH 1991

The History of Meteorology

Programme

0930	Registration (£3 , to include coffee / biscuits)	
1000	K. Commins (Valentia Observatory)	Historical Meteorological Instruments
1040	Dr. Ciaran Brady (T.C.D.)	Impact of Weather on Irish History
1130	***COFFEE***	
1200	M. Connaughton (formerly Irish Met. Service and W.M.O.)	World Meteorological Organisation
1240	***LUNCH*** £10.50 + 15% s.c. Please book at registration.	
1400	Dr. J. Tyrrell (U.C.C.)	18th Century Weather Records in Cork
1400	A. Heussaff (formerly Irish Met. Service)	Weather in Irish annals/publications to mid 19th century
1520	***COFFEE***	

1600 **A.G.M. 1991**

The full committee (as of March 1991) is as follows:

J.A.Scott	Re-elected 1990	President
S. Browne	Elected 1989	Vice-President
A. Kelly	Elected 1989	Secretary
J. Doyle	Elected 1989	Assistant Secretary
S.McCarthy	Elected 1990	Treasurer
M. Mansfield	Re-elected 1990	Assistant Treasurer
K. Commins	Elected 1989	
G. Fleming	Elected 1989	
M. Naughton	Elected 1989	
P. Vardon	Re-elected 1990	
E. Cusack	Elected 1990	
S. Walsh	Elected 1990	

The following are offering themselves for re-election at this A.G.M.-
S. Browne, A. Kelly, J. Doyle, K. Commins, G. Fleming and M. Naughton.

Agenda

1. Secretary's Report
2. Treasurer's Report
3. Elections to the committee
4. Activities
5. A.O.B