

## HYDROLOGY AND THE ENVIRONMENT

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I am glad to have the opportunity to speak to this meeting of the Hydrological Society, for although I am not a hydrologist, in my previous soil studies and research administration I have been involved in the same area of operations as hydrologists and have consequently known and worked with many of you personally.

When your President asked me to give this address he told me that your Society is undertaking a serious self-examination of its role, and that perhaps I might talk on this topic. This set me thinking, and I began asking people who should know, the very simple question: "What is hydrology?". I received two sorts of answers, ranging from the very helpful "I'll send you some notes about this", to the rather less helpful dictionary-type definitions. But I was surprised at the variety of answers. When I explained why I was asking the question, the most consistent advice I received was "Don't talk about hydrology to hydrologists if you are not one of them." I have been talking to specialist groups long enough since I ceased to be a specialist myself, to appreciate that advice. But I felt I would like to know more about what hydrologists themselves are thinking about hydrology, so I went to your Journal. I found these matters had been discussed in detail for several years. I found that hydrology is "the fundamental science required for all water management projects". I found that Ven Te Chow in 1972 said that most hydrological phenomena are so complex that they are beyond human comprehension, as quoted in the President's address in 1973. Discouraged, I read on, and in 1974 I found the definition "if it is wet or only damp, then it is hydrology". This seemed to me to include the dog's nose and both ends of the baby. Time was running

out for the preparation of this address and my brow and my palms were beginning to be classic examples of hydrology defined in these terms. But in the same editorial I did find a definition of hydrology accepted by the United States Federal Council of Science and Technology. It states that hydrology "is the science that treats all the waters of the earth, their occurrence, circulation and distribution, their chemical and physical properties, and their reaction with their environment, including their relation to living things. The domain of hydrology embraces the life history of water on the earth."

What right have I, who know so little that I have to look up such definitions, to talk to you? Perhaps it is because I am in a position from which I can have some sort of overview of the way different aspects – political, scientific, economic and administrative – are interacting with each other and impinging on major considerations of which way New Zealand should develop. For, more than ever before, people are concerned and involved in how New Zealand should develop; more *concerned* because they have a better knowledge and understanding than ever before, because some of the limits and some of the alternatives are better presented than ever before; more *involved* because there has been a fundamental change in our democratic system. It used to be to elect a government or a city council or a hospital board, and then leave it alone to get on with the job for which it was elected. Now we elect our governing bodies, but we expect them to consult back frequently and clearly so that public opinion and public reaction may become important factors in the decision-making processes. The mechanisms by which this is best done are still in a very early stage of development – a mixture of legal procedures and administrative systems which are not yet tidily integrated. Hopefully, tidiness and efficiency will gradually emerge, but the important factor is that people are thinking, and expecting their leaders to think about the real, long-term implications of projects being undertaken and of policies being developed.

It is only over the past few years that large numbers of people have become really interested in matters concerning the environment and conservation. Today conservation is an 'in' topic: if well-known people comment on it they are reported, and if they continue to do so, they are labelled as 'conservationists'. Today local issues are likely to be debated in public by a 'conservation group' – a few years ago this was the role of the local 'progressive association'.

The wide range of 'experts', some of whom tend to operate outside their true fields of expertise; the number of new organiza-

tions inside and outside of government; the scientific disciplines, sub-disciplines and combinations of disciplines impinging on many of these questions, ineffectively co-ordinated and integrated by technologists and inadequately understood by the public; the great practical difficulty of applying multi-disciplinary studies to multi-objective planning; the stresses and strains of using machinery of government (designed primarily to meet the demands of the public) for planning and managing diminishing resources for the optimum public good, to respond to the basic question which is changing from "Here is a public need, where can we find the resource to meet it?" to "Here is a resource, how can we use it for the greatest public good in both the short and long term?": these new conditions, motives, and objectives have produced bewilderment and confusion in the minds of a large section of the community who are aware of these issues but are not sufficiently interested or informed to really understand what is going on.

Dr R. G. Downes, Director of the Ministry of Environment and Conservation in Victoria, in his Meredith Memorial Lecture last year said:

"This confusion is compounded when the press, radio, and television always seem inclined to present conservation as a conflict. Even a difference of opinion between sincere and dedicated people about the means of attaining common objectives is converted to a major conflict between them.

"Two things are required to overcome this confusion. Firstly, more explicit meaning must be brought back into the words 'environment' and 'conservation'. These meanings have been blurred by their constant use by people who have little understanding of them. Secondly, because conservation has been presented to the public as a conflict, goodwill seems to have become a scarce commodity among those actively engaged in its achievement. There exists a peculiar philosophy that, if one is not rabidly for a point of view, then one is automatically against it, and all other conservation objectives as well. Furthermore, if one dares to have a different point of view, one is attributed with some sinister motive for having it.

"Perhaps a deeper understanding of the real meanings of the words 'environment' and 'conservation' would overcome most of the confusion which exists at present."

'Deeper understanding' and 'real meanings' are, I believe, what is really needed to bring science and society closer together so that science may adequately serve society.

David A. Poole, writing in the *Journal of Soil and Water Conservation* in 1971 had this to say about science and society:

“Resource professionals have allowed themselves to be led, cajoled, and pushed into a box canyon. The canyon is bounded by the inflexible limits and narrow dedication that most of us seem to accept for ourselves as the true meaning of our work.

“On some counts we have been trapped by our reluctance to pull an oar against the tide of common human frailties – greed, ignorance, and self-seeking. On other counts we suffer because of stout insistence that faithful discharge of our professional responsibilities requires a single-minded effort to prove the theoretical foundations of a particular discipline. Through policy statements, resolutions, and similar paper devices, we professionalize ourselves to the point of getting involved, if only at a distance, but seldom committed. In fact, the point of such devices sometimes appears to be avoiding commitment.

“No one can argue that soil science, forestry, wildlife, or any other discipline is not more advanced today than ever before. But despite this advance, much of it introverted, there exists the real fact of public dissatisfaction with the conduct of resource programmes. Nonprofessionals, people who feel their interests are being shortchanged, are forcing major programme realignments.

“Leadership for change is coming largely from this non-professional rank, much of it from individuals and groups who are asking professionals to do more than simply practise their individual specialties. They are asking that the whole environment, including the society of man, be taken into account in the pursuit of resource programmes. . . .

“Sometimes I wonder if professional societies have a social conscience. Too many of their platforms and policies point inward, expressing faith in and determination for a chosen work that oftentimes bears little relevance to a profession’s abilities and responsibilities to contribute to a better society. . . .

“I wonder if we don’t spend too much time attempting to prove and conform to the cherished philosophies of our chosen professions rather than forcing them to perform fruitfully for man. Of course, the latter is more difficult, but also more appropriate.”

I make no apology for that lengthy quote – I think it is right on target concerning your Society’s future role, and so I want to

lift your horizons to the world scene with another quotation – this one from Maurice Strong, retiring Director of the United Nations Environment Programme addressing the 13th Pacific Science Congress in Vancouver earlier this year. He said:

“The environment issue cannot be seen in isolation from the whole complex of difficult issues which today confront virtually every nation – inflation, energy, food, population and social turbulence. And these in turn are inextricably linked with the fundamental issues of war, peace and human survival. They are part of a complex system of cause and effect relationships in which the dynamics and direction of our future are being shaped. They increase by many orders of magnitude both the potential for conflict and the need for co-operation. While many of these issues are not in themselves new, they have been given a wholly new dimension and character by the unprecedented scale and intensity with which they now bear upon us. We cannot regard them simply as extensions of old issues which can be resolved by accelerating or expanding our traditional responses. For now that our own activities have become a decisive factor in determining the future of the human species, we cannot avoid the responsibility for controlling those activities. In effect we must manage our own evolution. This will clearly require a degree of enlightened political will and co-operative behaviour beyond anything human beings have yet manifested.”

That is a world viewpoint – what about New Zealand?

We are complacent about our environment. We realize that we do not have such critical problems as more heavily populated, more highly developed, or older countries; but we forget that we have changed the face of our landscape more quickly than any other country, and have developed a momentum of change to which we have become very accustomed.

The natural environment, some aspects of which were so attractive to our early settlers, has ceased to be the norm for New Zealanders. People today only experience it in reserved areas such as parts of our National Parks. In its place we have substituted a man-created environment which ranges from slight modifications to the original through to the totally artificial environment of the ‘concrete jungle’.

Change in our environment is inevitable; part of our personal and community aims is to adjust our environment to be more suitable for our needs, our comfort and pleasure. Few would relish living in a completely unaltered natural environment – and our

people would be hungry if we did! But we have become so successful in altering our environment, and have developed so many powerful tools to do it, that even here in New Zealand the decision on what we really want is more difficult than discovering the technical means of achieving it. In many areas the technology of environmental improvement is available if society is prepared to bear the cost, and the two questions arise, "What do we want our environment to be like?" and "How much are we prepared to pay for it?" And the questions are not as simply answered as they were 10 years ago. Then, we generally felt that the growth was good and the more the better, that the changing skyline was an expression of progress and GNP figures told us most of what we wanted to know about our success in moving towards our national goals.

Our views have changed – perhaps a most critical point was the National Development Conference in 1968. The structure of the conference was based on 14 'sector' councils, all oriented to economic concepts. It was during that conference that the decision was taken to set up two more councils – the Environment Council and the Social Development Council – marking, I believe, a radical change in emphasis and a recognition that New Zealand's development cannot be considered without giving due attention to social and environmental issues alongside and together with economic issues. This recognition is leading to interesting developments in bringing together the social scientist to identify what society wants, and the natural scientist to determine how it can be achieved. Though the techniques are complex it is becoming much more widely recognized that systems can be developed and must be better developed in the future, which can achieve a harmony among physical factors, population size and distribution, economic growth and development, utilization of natural resources and the physical and psychological needs of people.

I can imagine that some of you are beginning to say "We are a long way from hydrology now, which is what we came to this conference to discuss!" But are we?

People are becoming very interested in and very concerned about the nature of the water resource – its ability to supply the community's needs in quality and quantity; its ability to absorb and redistribute wastes, whether these are sewage or industrial discharges, or leakage of nutrients from farming operations; its ability to recondition itself in its own natural environment. Perhaps because water is so essential to man, people find relaxation and recreation in water in good state in nature – perhaps finding reassurance in seeing that this element in the life system is there in good condition

and in large quantity. Conversely, there is strong repugnance in contaminated water and frustration in finding that in removing pollutants from one section of the environment we contaminate another section. People are in fact becoming more aware of the unity and the interrelationships of nature and the biological systems such as exist in water. People want pollution confined and are alarmed at signs of widespread deterioration, even slight, in what they have considered to be natural waters. People are even beginning to realize that if we are to understand how much bending the natural system can stand, we must understand the natural system itself. They are realizing that eutrophication is in fact a natural process, but they are alarmed at actions which might lead to the acceleration of this process. And it is salutary for us to remind ourselves as scientists that in asking these questions, the people are not very far behind the scientist – for we have only been seriously working on them for a relatively short time.

Over the past year I have moved from a position in which I was responsible for the operation of a major research organization seeking to provide scientific information on which management programmes could be based in agriculture, forestry, human health, industrial manufacturing and processing, to an area where I see much more closely the genuine interest and concern of this large section of the community for the whole system of which human life is a small but very dependent part. The research scientist can retreat behind his technological facade and say those people don't know what they are talking about – they don't understand the basic science involved – they don't understand the processes, the checks and balances, the buffering capacities and the recycling and feed-back corrective systems. True, they don't; that is why they are asking, and that is why they are concerned. Unless we feel that we are entitled to a smug superiority and a God-given unaccountability – and I don't think we have this privilege – then I believe we have a duty to help people as far as we can to have the answers to these questions. It is with this background that I want to suggest to you some aspects of the role of the hydrologist which I think are important in New Zealand today.

*Firstly*, the hydrologist has the prime responsibility of securing all the basic information he can about water in the environment. We in New Zealand are fortunate to have most of our basic resources much better documented than many other countries; we know a lot about our rocks and our soils, and our plants, both indigenous and exotic, but our water with its complex biological and chemical functions is much less completely characterized and

there are still great gaps in our knowledge of what is there and what it is doing. It will be a long time before we know our waters really thoroughly, but in the meantime the hydrologist has a responsibility to ensure that real progress is made towards this end, deciding in some way or other what are the most important gaps to be filled and trying to ensure that these are tackled first. The layman who wants to use science in planning his management programmes is shocked when the scientist has to say "I don't know". We have all come to rely on an increasing pool of basic knowledge on which we draw as we become more sophisticated in our basic knowledge of living things. The great widening of motives which is so characteristic of our efforts towards meeting environmental quality has called for a much wider base of fundamental data, so I consider the first responsibility of the hydrologist is to add to this ever-increasing pool of basic knowledge.

*Secondly*, the hydrologist must be prepared to look at his science in the context of the system as a whole – he must develop a capacity to see beyond his own specialist area, beyond hydrology into the whole natural system. He must be a good scientific collaborator in this multi-disciplinary age.

I think the most effective contribution in this role is played by the experienced specialist who lifts his horizons and applies his expertise to wider implications and relationships. During a research scientist's career it is interesting to watch his motivation change. Initially he seeks to establish his own scientific standing among his scientific peers, frequently by highly specialized studies. Later, his motivation changes towards greater emphasis on the application and on the implications of his science, sometimes to the extent that his chief satisfaction is explaining and extending his scientific work towards its effect on humanity. I think that in New Zealand large numbers of research workers whose careers began in the post-war decade are now entering this stage, and as the 'call' becomes more incessant for broad vision and wide interpretations, I hope that hydrologists will readily apply their skills and make their contribution to this integration of science for society.

*Thirdly*, he must be prepared to assess the present stage of knowledge in his field – undertake 'state of the art' studies – and he must assist in making informed judgments when he cannot draw scientific conclusions. This might sound easy, but it is not. Good reviewers of the current state of the art are fairly rare because it is a skill requiring patience and objectivity, as well as scientific understanding in both breadth and depth. But, when this has to be coupled with the ability and willingness to make judgments beyond



the range of the data available, this type of person is even more rare. It is not good enough to settle for Ven Te Chow's statement that I quoted at the beginning, that most hydrological phenomena are so complex that they are beyond human comprehension. Practical problems are coming thick and fast: indigenous forests being converted to exotics, urban developments in sensitive catchments, reclamations in enclosed waters. We cannot hope to have all the information available on all of these before decisions must be made, so the decisions must be taken based on informed and reflective judgment using the best available knowledge. And that requires special skill and special courage in the scientist if he is to make his most effective contribution to society.

*Fourthly*, he must be prepared to explain to people what he is doing and how it will really affect the environment which he and his children will share with them and their children. Some scientists are poor at explaining their work; some have become quite adept at explaining what they are doing, but only a few are ready with a good answer as to why they are doing it. Because of the current policy of informing the public and seeking contributions from the public on issues involving the management of the environment that people live in, there is a great deal of interest and concern in what scientific information really means and what its implications really are. The public is much better informed, asks many more far-reaching questions and is genuinely much more concerned than ever before that the right decisions are taken, based on the right data. The scientist must therefore be prepared to be subjected to much closer scrutiny than ever before, and to present to the layman his findings and his judgments much more clearly than ever before. Just as the farmer expects scientific facts to be interpreted for him in a management plan which he can understand and on which he will stake his work and resources, so the public is now expecting to receive an environmental management plan which can be readily understood and on which society will stake its way of life and the future well-being of its children.

I have spoken to you as hydrologists in terms which generally apply at the present time to all natural scientists. But as I conclude, I should like to refer again to the role of your Society. There is freedom and independence in a learned society—freedom from restrictions which may, quite necessarily and reasonably, arise from the policies and programmes of our employers, whether they be state, local authority, or private enterprise. This freedom from policy inhibition means that some things can be done and said by the Society which cannot be done or said by individuals. But

I would remind you that there are two aspects of freedom – both enjoyed by your Society – freedom *from*, and freedom *to*.

As your Society enjoys its freedom *from* outside direction and inhibition, I suggest that it has a corresponding responsibility to exercise its freedom *to* ensure that the science of hydrology in New Zealand reaches the highest possible technical standards, its freedom *to* ensure that the science of hydrology in New Zealand makes the most effective contribution possible to the future well-being of New Zealanders, and its freedom *to* ensure that the people of New Zealand understand as far as possible the significance of hydrology in the management of our environment for the future.

For the next 100 years, world development will be dominated by finding ways of balancing people with resources. This balance must be achieved within the 100 years. If it is, a new life of stability and satisfaction could emerge for the people of the world; if it is not, only chaos can result. And water in the natural environment is one of the critical resources.

I hope that your Society looks outward and responds to such great opportunities and such great challenges. Remember, “the domain of hydrology embraces the life history of water on all the earth”.

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