THE ROYAL BANK OF CANADA
MONTHLY LETTER

VOL. 46, No. 3 HEAD OFFICE: MONTREAL, MARCH 1965

Canada and the Hydrologic Decade

BECAUSE WATER is the central material problem of mankind, the nations of the world have banded together to study it over the next ten years. They call this operation "The International Hydrologic Decade".

There is more water on the earth than man can use, but most of it is salty and therefore unfit for drinking or for irrigating crops. The small amount of fresh water that is available varies from time to time and from place to place. What is readily at hand is more often than not so polluted that it requires extensive treatment, even for industrial use.

Up until now we have been content with short-run measures involving engineering and management. As demand increases its pressure on our limited resources the need becomes peremptory for improved scientific knowledge. We do not know enough to cope efficiently with complicated water problems.

The water of our rivers and lakes, if left to itself, would be self-perpetuating, renewing and cleansing itself eternally. But man has stepped into the scene and has upset the natural balance. By his insistence upon unlimited freedom to reproduce, and by his demand for an endless variety of industrial and other products, man now threatens the stability of his own existence.

The Hydrologic Decade is not primarily a time in which to build great waterworks, but a time in which to learn the facts so that building can be soundly done.

At the end of ten years of observing, recording, experimenting and classifying by scientists from more than fifty nations, it is hoped that governments and water management people in every country will be able to think clearly and judge wisely and build effectively to preserve the supply of water which is essential to our human existence.

This is basic research, true discovery. The idea arose in the minds of scientists whose studies had convinced them that steps must be taken immediately to keep the earth fit to live on. Up to now our water problems have been solved temporarily in municipal, county, provincial or national spheres of authority, but water is no respecter of man-made boundaries. A world-wide assault is needed, with simultaneous observation and measurement over all the surface of the earth.

Science itself is international. The late vice-president of the U.S.S.R. Academy of Sciences put it this way: "The entire history of science shows that every national scientific community has only been adding its bit, large or small, to the great cause of scientific knowledge of the world, a cause common to all humanity."

There never was a cause more urgently demanding international co-operation than this study of water. The occurrence and distribution of water in any country is a consequence of the circulation of water on the whole earth. We need to know the universal laws which govern this cycle, not only in space but in time.

These involve the effects of the sun's rays, the evolution of heat in the earth's interior, the precipitation on Mount Everest and on Mount Logan, whirlpools in the stratosphere over Antarctica, the discharge of rivers, the breaking away of icebergs from the glaciers, the position and bulk of buried salt beds, the minute movement of water through earth's porous rocks, the direction and quantity of the great ocean currents, the deluge which follows the south-west monsoon on the borders of the Indian Ocean, the dust-laden dry wind of the Sahara, and the many water-using activities of mankind.

Above all, no time must be lost. Deterioration of our water supply is proceeding at a disconcerting speed. The challenge to protect human life by saving its most vital resource may no longer be deferred.

Hydrology

The hydrologic cycle is the circular movement of water from the atmosphere to the land, and, through a large variety of processes, back to the atmosphere. Hydrology is the science of water, its occurrence, circulation and distribution; its chemical and physical properties; and its interaction with its environment and with various forms of human activity.

Many aspects of the relationships of water and other things are still obscure, but it is known that the most damaging impact of civilized man on his environment is the shattering of the hydrologic cycle. "It is possible," says William Vogt in *Road to Survival,* "that this reduces the amount of water that falls. It is certain that, to a critical extent, it reduces the amount of water available to man." Were the cycle to be stopped for some cosmic reason, all water would finally come to rest in the oceans, and life could continue only in the marine element.

Because these crucial facts are not generally recognized, many of the adverse effects of man's activity were not foreseen in advance of their occurrence. We do not yet understand the forces with which we are dealing. Without knowledge we are heading for more and bigger problems . . . and for eventual extinction.

The first thing to do is to gather basic observation data upon which research workers can formulate principles and evolve theories making it possible to predict water conditions. Then practical application will open up new prospects and lead to rational development of our water resources.

The preliminary work is not simple. We have too few men and women trained in the science of hydrology. Recruits are needed in this area of science which holds out great promise of interest and achievement to existing and potential scientists.

This decade

The International Hydrologic Decade developed from discussions during the International Union of Geodesy and Geophysics meeting in Helsinki in 1960; a year later the idea was endorsed by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Meteorological Organization (WMO), the International Association of Scientific Hydrology (IASH) and other international organizations; and when the preparatory meeting was held in Paris in 1963 there were 48 nations represented. At a meeting of experts in 1964 there were 57 participants. This is truly a great international venture in scientific co-operation.

Those engaged in the decade of observation and research will be providing information on which the social, physical and biological sciences may combine to do something effectively about water problems.

The specific research programmes will differ from country to country. In North America and Europe the emphasis will be on sophisticated projects such as sediment transportation in relation to the length of life of dams and the movement of rainwater into underground water storage. In less developed countries the effort will be toward systematic and continuing measurement of stream-flow and groundwater levels so as to draw up water budgets based upon the resources available.

All of this cannot be done in a short time, hence the ten year period of the project. Rainfall and waterflow vary from year to year in every country, and a decade is all too short a time for adequate measurement. It is, however, a period that will give enough information to make this a turning point in history.

Just as the International Geophysical Year revealed dynamic events in space, like radiation belts that wax and wane; deadly protons shot out by the sun and drawn toward the earth's poles; and the sun's eruptions of hot, magnetized plasma that may provide clues to the harnessing of unlimited nuclear energy, so this decade of research into water will provide new and yet unthought-of knowledge that will be vital to continuance of human life.

In contemplating the Hydrologic Decade, therefore, we must lay aside for the time being our small thoughts of local water problems. The knowledge gained will be of the basic science, leading to increased ability to bend the forces of nature to the benefit of man.

Many techniques will be used. There will be networks of observation stations recording rainfall, the rate of river flow, evaporation, soil moisture storage, quality of water and the amount of sediment it carries.

One project of noteworthy consequence will be the establishment of international hydrologic stations to provide comparable observations on a continuing programme at the same place and time. This standardization of information will make it readily useful to scientists of all nations.

Canada's contribution

The participation of Canada is of selfish interest as well as being an evidence of international co-operation. There are regions in Canada which have recurring drought problems and others which are subject to floods. Much of our industrial economy is based on cheap hydro-electric power which requires a dependable supply of water. In Alberta and Saskatchewan we have 1,500,000 acres under irrigation.

Someone has estimated that more than $3,000 million will be spent in Canada during the next ten years on hydro-electric power development, flood control, water conservation systems and irrigation projects. International research during Hydrologic Decade will help to ensure the efficient design and operation of all these projects. By working with others we shall reap benefits far beyond those to be gained by working alone.

Our contribution will include a national inventory of water balance, and the expansion of our observation networks for co-ordinating data. Special research will be undertaken on the formation and melting of lake and river ice, the effect of ice on river flow, the application of weather satellite data for snow and ice calculations in remote areas, the techniques for locating groundwater in the prairies, and the methods of appraising stream-flow, precipitation and evaporation.

The National Research Council's Canadian National

Committee for the International Hydrologic Decade is the co-ordinating body. This committee is made up of representatives of federal and provincial agencies and of universities. It has been assisted in its task of drawing up Canada's initial programme by the Council's Subcommittee on Hydrology, and, since glaciers form an important part of Canada's stored water, by the subcommittee on Glaciology.

To fulfil its Decade obligations, as well as to manage its own resources effectively, Canada needs a greatly expanded observation network. A report to the National Research Council says that there are no sizable areas in Canada which have truly adequate hydrometeorological observation networks. In rain-gauge networks, for example, Canada lags seriously behind other countries of comparable economic development. New Zealand has 14.2 gauges per 1,000 inhabited square miles, compared with Canada's one, and 6.1 gauges per 10,000 people compared with Canada's 1.1. Comparisons with network densities in the United Kingdom, U.S.S.R. and the United States are much less favourable to Canada. The same situation applies to evaporation, stream gauge and groundwater level networks.

Another major activity will be the setting aside of some 50 watersheds of moderate size, representing all the variations of climate, geology, soils, water quality and vegetation found in Canada. Instruments will be used in these watersheds to measure precipitation, stream-flow, groundwater levels and evaporation.

About six small watersheds will be used to determine the effects of man-made changes on the water balance of natural basins. Studies will be made of swampland drainage, tree-cutting effects, irrigation, and erosion. Some basins will be selected as what are usually called "wilderness areas". They will be left undisturbed, except for the installation of instruments, to give a continuing basis for comparison over the years with basins subject to human molestation.

It becomes evident, from this partial list of projects, that there is much for Canada to do during the International Hydrologic Decade. One of the first essentials is to promote the training of scientists and engineers in hydrology and related fields. A series of training seminars has been set up to provide some of the needed staff.

Urgency of the research

It cannot be said too often that fresh water is a critically important resource, and that adequate conservation and wise use of water will be a decisive factor in the future well-being of mankind.

Everyone is aware of the progressive pollution of our lakes and rivers, and the hydrologists are conscious of the danger that threatens our whole water economy. What tends to be overlooked is that the drain on water fit for household, industrial and irrigation use is moving toward the perilous point of no return.

There is an automatic increase in demand for water due to population growth. Because of this increase alone, says the UNESCO *Courier,* in twenty years time we are likely to be needing more than three cubic yards of water where two suffice today.

The problem, obviously, is not one for arid lands alone. In fact, the higher our standard of living rises the more demand there will be for water to service homes, industries and agriculture and to remove our wastes. The United States Department of the Interior estimated water consumption at a daily average of 359,000 million gallons in 1965, a jump of 100,000 million a day in the past decade and almost 320,000 million since the beginning of the century. By 1980, consumption will be at the rate of 600,000 million gallons.

Southwestern Ontario, almost surrounded by three of the world's biggest lakes, has already tasted drought which reduced its winter wheat crop and affected adversely the dairy business and beef production. A year ago in Dallas, Texas, residents queued up to buy water at fifty cents a gallon; in New Jersey a leaky faucet could cost the owner thirty days in jail; in other parts of the country schools were closed, industries cut back, construction halted, and car washing prohibited because of water shortage.

This international effort is, then, no merely academic exercise. The absolute necessity of increasing the degree of rational management of water, based on detailed and authentic knowledge, is recognized. We need reliable information on which to base measures to maximize the usefulness of water for the farm and for the home, for power development, for navigation, and for industry, while at the same time we minimize the adverse consequences of floods, pollution, salting, and river degradation.

Desalting the sea

Every quart of sea-water contains about an ounce and a half of salt, and no one has yet developed an economical way of removing it. Research is going on along several promising lines, but the solution is not just around the corner.

Only special economic and geographical situations have so far justified the setting up of large desalting plants. There is one in Kuwait, on the Persian Gulf. When the oil resources began to be developed it was necessary to import water by tanker, at high cost. Some large scale water distilleries have been built, fueled by natural gas and oil, producing more than ten million gallons of fresh water a day. Although expensive when compared with the cost of water in other parts of the world, in Kuwait the desalted water is cheaper than imported fresh water.

Some people think that there is another solution that may be effective instead of desalting. Desert herdsmen have trained some valuable animals, such as camels and caracul sheep, to drink water with a high salt content and these animals gain weight regularly and breed normally. It is suggested that water with a salt content as high as sea-water may be used to irrigate farmland.

The ideal would be to so organize our use of fresh water as not to be forced to call upon the sea for its expensive substitute, and to preserve our underground water supply from contamination by salt water.

Underground storage

The United States Geological Survey has brought forward a list of thirty groundwater problems that need research. One writer says that there has been no really fundamental advance in knowledge of groundwater hydrology and hydraulics principles in the past twenty-five years.

Almost all rocks and the cover of sand, clay, mud and soil have some pore space between the particles which make them. This may vary from nearly none at all in dense rocks erupted from the heated interior of the earth to as much as thirty-five per cent in some very porous materials. If the pores connect with one another then water will be able to trickle through them and the rock is said to be permeable.

This is the store of water which we, mistakenly, are inclined to take for granted. It is 3,000 times greater than the amount of water in the rivers of the world at any given moment in time, twenty times larger than the amount of water in all the freshwater and inland seas in the world. It can amount to as much as a million cubic miles of water. Some of the water in underground deposits may have been left there a million years ago.

But to know these things is not to know in how far we may depend upon the supply. We do not know exactly what happens in the relatively thin layer which preserves the moisture. What form, liquid or vapour, does the water take deep down? What forces act upon the water? How long will this life-giving moisture last? What part does a forest play in the passage of water to underground reservoirs? These are the kinds of problems which still have to be resolved, and which it is hoped will be resolved in some measure by the International Hydrologic Decade.

One thing is certain. Underground water is not a fully-renewable natural resource. It tends more and more to be "mined" like ores. If it is to be made to last for benefit of the human race it must be recharged. As someone said, man is the one disorderly element in an otherwise orderly environment: if man's depredations are to be made good, that is man's responsibility. His activities at present are withdrawing water from the underground storage faster than it is being replenished.

Man and nature

Man must begin to show more respect for his environment. As our technology advances we indulge in more and more practices that are offensive to nature.

What are these practices? We change climatic and hydrological conditions by the building and operation of hydraulic engineering works; we build cities, clear land, and drain swamps, thereby changing the quantity and quality of water in river basins, in underground storage and in soil; we change the quality of water through using it for industrial, agricultural and domestic purposes.

Take as an example the pollution of flowing streams by the waste from cities and the poisonous run-off of insecticides. We know the value of clean water for human consumption, yet communities continue to vote against proper treatment of sewage and higher governmental authorities hesitate to say "thou shalt not" to those who pour noxious matter into streams and rivers. The International Hydrologic Decade will have served a good purpose if only it brings responsibility home to those who can do something to remedy this disastrous trend.

Pollution is not a new problem, but it is a problem that is pyramiding with the sophisticated needs of society. Out of the vortex of technological advances and urban expansion have come an increasing volume and increasingly complex array of industrial and sewage wastes to contaminate water: detergents, insecticides, chemical mixtures, and the radioactive ash of nuclear production. Even the oil-slick from freighters ploughing the inland seas adds its menace, because by reducing the capability of the water to absorb oxygen from the air it retards the natural process of self-purification.

There is no suggestion that International Hydrologic Decade will restore our polluted rivers to salmon and trout streams, but at least it will inform us beyond scientific doubt about what is going on to our detriment. It may administer a salutary shock, quickening our desire to do something by way of worldwide strategy and hometown effort toward making human destiny more hopeful.

or else. . . . ?

What is the alternative to gaining this knowledge and doing something with it? We read the answer in the ruins of ancient civilizations, which were as advanced in their day as we are in ours. Babylon and greater nations before her died in the dust because they failed to manage their water resources.

The solution of water problems in times past was to migrate to an area that had not yet been despoiled. Two hydrologic scientists, R. L. Nace and L. J. Tison, take up this solution in their article "International Co-operation In Scientific Hydrology" and declare unequivocally: "After 5,000 years of solving mistakes by fleeing from them, that solution is no longer possible because there is no place to which to go. *It seems evident that man is approaching a crisis which, unless adequately prepared for, could bring disaster within the lifetimes of people already born.*"

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Post Office Department, Ottawa.

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