BRANTA

NEWSLETTER OF
THE FORT WHYTE CENTRE
Winnipeg, Manitoba, Canada

July/August 1989, Volume 7, Number 4 ISSN 0824-5126

WATER IN A WARMER MANITOBA

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About five and a half thousand years ago, near the eastern edge of the prairie, lay a wide and empty basin. Miles of mud flats and gravel banks were dotted with brackish ponds, the only remnants of Lake Manitoba. The lake was to remain dry for a thousand years; then slowly, through climate change, it would refill to levels of today.

Climate Change Past

Climate change has bedevilled the world since its beginnings. We know that there were tropical climes in what is now Canada, and that in contrast there were ice ages; the last great ice age spanned most of the past 100,000 years and world temperatures were 5°C to 15°C below what they are at present. For the last 10,000 years we have been in a warm interlude, but if nature has its way we have passed the warm peak and are about to begin a long slide toward the next glaciation. Fortunately this would take thousands of years!

Even within this comfortable interlude, climate has not been stable. A few thousand years ago Mediterranean countries were wetter and agriculture prospered, while much of the interior of North America was very dry. There was a vicious cold snap in the 17th and 18th centuries called the "Little Ice Age", and up until a few years ago the steady rise in world temperatures (about 1°C in western Canada in the last 100 years) was regarded as a rebound from that cold period. That it may not be entirely a "natural" rebound is now becoming apparent.

"Available Water": a scarce commodity in Manitoba in the next century?

A New and Ominous Force

A new player has stepped upon the climate stage — man — and unless something is done to modify his role, he will be cast as villain. It is now clear that we have the power to overcome nature and alter the climate of the earth.

How can man wield such power? It has to do with the earth's heat balance: the amount of incoming heat from the sun is usually equalled by the outgoing heat given off by the earth to space. If they are out of balance for any length of time, the earth will heat up or cool down, as indeed it has over the ages. Imbalances that have led to cooling and ice ages are believed to have been caused by astronomical changes. Shorter period variations are the suspected result of sunspots, volcanic eruptions, changes in the earth's reflectivity and other influences. Recently mankind, unkowning or uncaring, has been hurling megatons of carbon dioxide and other gases into the atmosphere, gases which do not hinder incoming solar energy but are gradually building up and blocking the return of earth energy to space. If unchecked, this buildup will steadily warm the world. It is popularly called the Greenhouse Effect.

Some call the Greenhouse Effect only a theory, since it cannot be proven beyond a doubt. The great majority of climatologists, however, accept it as a sound theory that will be proven over the next few decades as temperatures warm beyond anything known in 10,000 years. There are signs which, although they are not proof, are the kind of signals that fit in with Greenhouse warming.

For example, the five warmest years in written world history have occurred in the 1980's.

A worrisome fact about Greenhouse warming is that it is something of a delayed effect; even if there were no more of these gases released, those already emitted would keep temperatures rising for some decades. We are already committed to some warming.

To estimate the scale of possible change, scientists are using computers to simulate the patterns of the atmosphere. Because of the immense complexity of the physical and chemical processes, there are many uncertainties and unknowns in this task. Nevertheless, the most sophisticated models agree that there will be warming. The five leading models give estimates of warming, averaged over the world, of 2.8°C to 5.2°C by the middle decades of the next century. Accompanying estimates of average world precipitation are for increases of 7 to 15 per cent.

Projections for Manitoba

The encouraging agreement in total world estimates falters somewhat when one looks at local areas. Temperature predictions hold up fairly well; the same five models yield warming for Manitoba ranging from about 1° to 6°C. They are not so consistent as to increasing or decreasing moisture, and about the best one can say is that they tend toward drier conditions in the interior of continents at middle latitudes, and that would include Manitoba. The models simply cannot deliver the details, mostly because the whole picture of water in the environment is very complex and varies from area to area. To try and develop the local picture, the popular approach is to look at scenarios. A plausible prediction of future climate is chosen, and available knowledge of local water processes is applied to determine the effects on available water.

What is available water? We are conditioned to think of precipitation as the appropriate measure of the wetness of a climate, but it is only part of the story. What is more practical is the availability of water we can use as moisture in the soil and as supplies from lakes, streams, reservoirs and wells.

A Manitoba Scenario

One possible scenario for Manitoba is that the average annual temperature will rise by 3°C by the year 2050. This is not a forecast, just one of many possible scenarios, one that is plausible in the light of current knowledge and one that would be considered too conservative by many.

First, strictly from a comfort standpoint, there seems to be no reason why Manitobans could not learn to live with — or even like — a climate that is three degrees warmer. Milder winters are particularly attractive! Summer would more often be uncomfortably hot, but on the whole temperatures in southern Manitoba would be similar to what they are now in South Dakota, and the Pas would resemble present day Winnipeg.

Apart from comfort, a warmer climate would naturally lead to many changes in agriculture, forestry and other weather sensitive industries. But the real concern is what that warmer climate might do to usable water.

Water in a Warmer Manitoba

Water evaporated from the earth returns as precipitation; higher temperatures would mean higher evaporation and higher precipitation. Unfortunately, precipitation would continue to be unevenly distributed around the world, and here in the northern interior of North America we are at a disadvantage. Moisture-bearing winds from the Pacific lose much of that moisture on the western mountains, and in the "shadow" of those mountains we would receive some increase but not our fair share.

The extra heat in the interior, meanwhile, would have its full effect on evaporation from soil, vegetation and open water, and usable water would decrease. Thus, even though precipitation might increase in the world sense, the climate of Manitoba would probably be drier as far as available water is concerned.

The estimation of future water levels in Manitoba is complicated by the fact that 70 per cent of the water in lakes and streams flows in from elsewhere. The great rivers are the Saskatchewan, the Winnipeg and the Churchill. Smaller, but still important, is the Red, and there are numerous other streams which originate outside our boundaries. The difficulties of assessing these far-flung sources are exemplified by the Saskatchewan River, which is fed by snowmelt in the Rockies.

Because of these intricacies, it has not been possible to research future Manitoba water in detail. The possibility of less water has been mentioned, and can be explored with useful information from elsewhere.

In 1987 the Great Lakes Institute undertook a detailed study of future water supply in the Great Lakes basin. The base scenario was one of the leading computer projections, that of the Goddard Institute for Space Studies, to which was applied appropriate local knowledge of evaporation, runoff, etc. Among the conclusions were the

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BRANTA is the newsletter of the Fort Whyte Centre for Environmental Education. The Fort Whyte Centre is a privately operated, non-profit project of the Wildlife Foundation of Manitoba (WFM). Registered Charitable No. 0336149-54-21.

The WFM was incorporated by Special Act of the Manitoba Legislature to provide funding and facilities for education in the art and science of keeping this earth habitable.

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BRANTA is published bimonthly and is sent to members and supporters of the Fort Whyte Centre. Annual memberships are available for families ($40.00) and individuals ($25.00).

Comments, suggestions, and appropriate article submissions are welcome. Please direct any correspondence to: BRANTA Editor, c/o the Fort Whyte Centre.

likelihood of much more frequent low levels, with mean lake levels down as much as 30 to 80 cm, and mean river flows reduced by 20 per cent.

Dr. Stewart Cohen of Canada's Atmospheric Environment Service and a hydrometeorologist of international standing, looked at the Great Lakes basin under a wide variety of possible future climates. He found that in a large majority of cases (though not all), water supply and soil moisture would be down; and that to maintain present conditions would require very significant increases in precipitation.

Dr. Peter Gleick, a leading American scientist, studied the potential runoff and soil moisture in the Sacramento basin in northern California for a range of future temperature and precipitation regimes. The results were surprising; under all the combinations summer soil moisture was reduced, even when precipitation was assumed to increase by 20 per cent.

The conclusions of Gleick, Cohen and the Great Lakes Institute reinforce the concept that in the continental interiors at mid-latitudes — and this includes Manitoba — higher temperatures would cause evaporation to increase more rapidly than precipitation. This points toward drying.

Ancient Evidence

Other evidence supporting a drier future is revealed by the study of ancient climates, particularly during the warm interlude of the past 10,000 years. The peak of this period appears to have occurred more than 5,000 years ago; at that time temperatures in Manitoba were probably several degrees above today's and not unlike those predicated by the Greenhouse Effect and our 3°C warming scenario. This article began with a reference to the drying up of Lake Manitoba, as reported by Drs. Teller and Last of the University of Manitoba. Near the same time, Devil's Lake in North Dakota also evaporated. The lack of moisture caused the forest to die back and be replaced by drier grasslands as far norhteast as the north end of Lake Winnipeg.

It must be emphasized that the disconcerting picture emerging is not a firm forecast. There are too many uncertainties to allow a detailed and definitive picture. Nevertheless, because the situation is unprecedented and could cause major disruptions to our way of life, we must make the following statement:

"Although there are many uncertainties regarding the Greenhouse Effect and its impacts, the weight of the evidence is toward a drier climate in the northern interior plains, including Manitoba."

Manitoba Impacts

What might be the consequences of a warmer, drier climate? The answers would fill a book, but here are some salient points.

- Of serious concern would be the reduction of water supply in the many areas which depend on smaller, local sources — streams, lakes, reservoirs and wells. Wildlife would also be affected as evaporation destroyed ponds and wetlands.
- The impact on large rivers and lakes would be slower and more uncertain, but some reduction is likely.
- Warmer winters would result in less snowpack and earlier, reduced spring runoff and floods.
- The more productive agricultural climates would be shifted northeastward, replaced by less productive, dry land in what are now our prime farming areas, and limited in the northeast by soil types unsuitable for agriculture.
- The forest zone would similarly be forced northeast.
- Water demand for human livability would increase.
- Water demand for irrigation and livestock would increase.

What Should Be Done?

What should Manitobans do, what can they do, to protect the future?

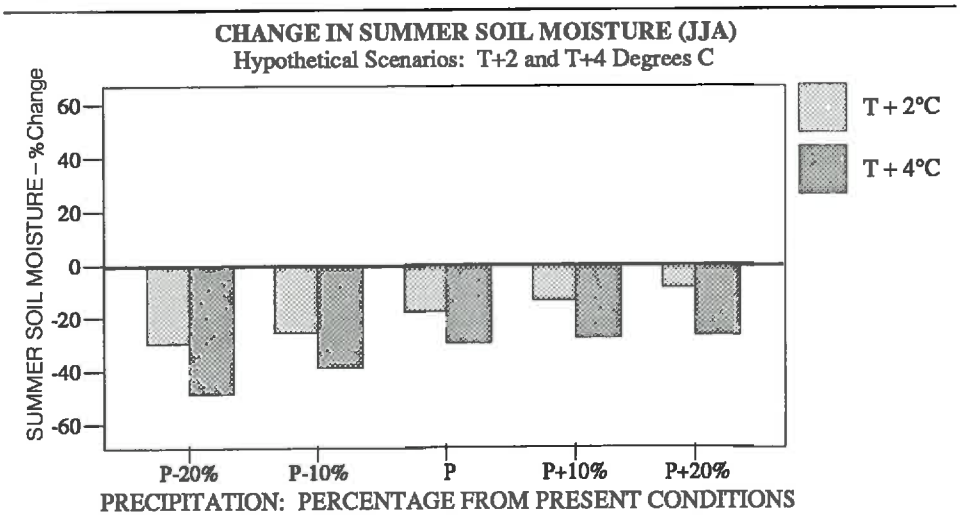
First, we should act on the assumption that we are committed to a warming and to a decrease in usable water. We should vigorously pursue and support programs that husband water and use it efficiently. This would cost relatively little and pay benefits whether or not predictions come to pass; for in our present climate hardly a year goes by without some part of the province suffering a shortage of water.

Second, we must support any measure that will limit the Greenhouse Effect. There is nothing to suggest it will abate by the middle of the next century; in fact, if nothing is done it will accelerate at an alarming rate.

How can we persuade the developed nations, including our own, to change, at staggering cost, the practices of generations? They are only now making the first hesitant moves against acid rain and the destruction of the ozone layer, which, though terrible, are lesser problems. And how do we persuade the governments of the poor and developing nations to forego industrial "progress" and the clearing of forests when their people are starving?

But try we must, for if it continues the Greenhouse Effect could make Manitoba too hot and too dry for our lifestyle and for life around us.

Hugh Fraser recently retired as Chief of Scientific Services in the Atmospheric Environment Services of Environment Canada. He resides in Winnipeg and continues to work as a Meteorological Consultant.



*This graph illustrates possible soil moisture changes in the Sacramento Basin in California under future climate scenarios. The ten cases look at warmings of 2°C or 4°C and precipitation changes ranging from +20% to -20%. **In all cases soil moisture decreases.** The research was done by Dr. Peter Gleick in Berkeley.*