High and Dry

Flushing our water down the toilet

by David W. Schindler

The current drought on the western prairies is the most intense since consistent weather records began to be kept, over a century ago. Most wetlands are dry. River flows are 40 to 80 per cent below normal. Lake levels are low: some have lost 50 to 100 per cent of their volume. Many groundwaters have disappeared, leaving small communities and rural residents literally "high and dry." It is time to reflect on the reasons for the drought and on what must be done to mitigate its effects, and the effects of future droughts, on our increasingly scarce prairie waters.

The Oldman Dam, among others, diverts water from the headwaters of the South Saskatchewan River.

PETER LLEWELLYN

DROUGHTS HAVE OCCURRED for millennia on the prairies. Paleoecological studies of fossils from organisms that are responsive to drought show this. David Sauchyn, a professor at the University of Regina, has used the widths of rings from trees and logs of known age to deduce the incidence of drought for the past 300–400 years. Similarly, Peter Leavitt and his colleagues, also from the University of Regina, have used species of algae buried in lake muds to model past climates from past lake salinity (which increases as water levels decline). Their analyses, which extend back to before the birth of Christ, suggest that past droughts have occurred with an average frequency of about four times a century, and about every third drought has lasted for more than a decade. The 20th century, which we have come to regard as normal, appears to have been the wettest century in recent millennia. None of the 20th century droughts lasted over a few years, and even the notorious drought of the Dirty Thirties appears very mild when compared to some droughts in earlier centuries. In short, we are overdue for a granddaddy drought.

Many dismiss the current drought as a natural phenomenon that will go away on its own. But while our current situation is probably part of a normal drought cycle, several human activities may amplify its effects. To begin with, due to greenhouse gas emissions our climate is the warmest it has been for several thousand years. Most sites in Alberta are now from one to four degrees warmer than they were in the mid-20th century. Evaporation generally increases with increasing temperature, so we can expect that rising temperatures will intensify droughts. Even if we quickly control greenhouse gases, another one to two degrees of warming is expected by the mid-21st century, as a result of emissions in the late 20th century. Atmospheric scientists predict that by 2100 global temperatures will be from three to five degrees warmer

than they were in the late 1990s. Many models indicate that the western prairies may warm even more than the global average.

This warming trend is also causing the glaciers of the Rocky Mountains to recede rapidly. Many will be gone by 2050. Glacial melt maintains the midsummer flows of rivers in the western prairies—the period when agricultural and urban demands are greatest—and is important for recharging groundwater supplies.

The winter snowfalls, which we assume will cause large spring flows in prairie rivers, are also in jeopardy. The incidence of dry El Niño winters appears to have increased over the last few decades. Professor Jim Byrne and his colleagues at the University of Lethbridge have modeled flows from the Oldman river basin under a changing climate. As the climate warms, winter snowfalls in the lower parts of the basin will trickle away during midwinter melts, leaving little for the springtime recharge of rivers. They project that in lower elevations of the Oldman basin, water from snowmelt will decrease by 50 per cent.

Moreover, during previous droughts we did not have three or four million people, numerous industries, irrigation for agriculture and several million head of livestock competing for the scarce water of the prairies. And we use more water now. We thoughtlessly use high quality water for irrigating, flushing toilets, injecting into deep wells for recovering oil and gas, washing away animal wastes and watering lawns, where poor quality water would suffice. In fact, it is not clear why we use a resource as scarce as prairie water for some of these practices at all.

TEMPERATURE INCREASES of a few degrees over several decades don't sound so bad to many people. We are accustomed to diurnal changes in temperature that are much greater. But as long-term averages, these predicted temperature increases are cause for great concern. Again, we can turn to paleoecology for some lessons from the past.

Many studies have been conducted in Canada on what kinds of trees have grown where over the centuries. By analyzing pollen, seeds and other materials preserved in lake muds and peat bogs, as well as fossilized stumps and logs, scientists deduce past climatic conditions. It is generally agreed that since the glaciers left the western prairies roughly 10,000 years ago, the warmest period before the late 20th century was during the mid-Holocene, 4,000–6,000 years ago. Temperatures are estimated to have been approximately 1° C warmer than the 20th century average in much of southern Canada.

There are indications that water was extremely scarce during the mid-Holocene. Studies by Jim Teller and Bill Last, both professors at the University of Manitoba, indicate that Lake Manitoba, the 12th largest lake on the continent, was dry during the period. The evidence is persuasive: layers of lake muds that can be precisely dated contain evidence that grass was growing on what is now the bottom of the lake. Bison, rather than fish, frequented the lake bottom during the mid-Holocene. In another study, Dale Vitt, a professor at the University of Alberta, and Steve Zoltai, of the Canadian Forestry Service, studied the age of peat deposits in prairie wetlands. They found that most wetlands of the central prairies and prairie parklands are only 3,000 to 5,000 years old, indicating that their basins were dry during the mid-Holocene.

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A contemporary example can also help us estimate the effects of a warming climate. Two areas of Alberta, one north of Fort McMurray and the other near Lethbridge, receive a nearly equal average annual precipitation of about 400 millimetres. Yet a flight from Fort McMurray to Fort Chipewyan reveals a very wet landscape with numerous large fens containing pools of standing water, while the landscape near Lethbridge is semi-arid—by midsummer, southeastern Alberta's grasslands generally turn brown, and its wetlands are dry even under normal conditions. A major reason for the differences in these landscapes is the difference in average annual temperature—about five degrees—with the resulting difference in evaporation. If models are correct, by the end of this century, much of northern Alberta will be as warm as the Lethbridge area. We will likely see northern Alberta's water supplies dwindle as a result.

AS OUR WATER BECOMES INCREASINGLY SCARCE, its quality also declines. Lower flows of rivers into and out of lakes cause chemicals to be flushed out more slowly. The resulting increase in nutrients (chiefly nitrogen and phosphorus) causes accelerated production of algal blooms with the associated consequences, collectively known as eutrophication. Already, the concentrations of algal toxins appear to

have increased during the recent drought. For example, the eutrophication of Lake Winnipeg has accelerated since the early 1990s such that its current water quality is comparable to that of Lake Erie in the late 1960s, when the "death" of that lake was predicted. One reason is the decreased flow of the Saskatchewan River. Its current flow at the river's mouth is less than one-fifth what is was a hundred years ago. The resulting decrease in the dilution of nutrients in Lake Winnipeg poses a serious threat to the water quality and fishery of the lake.

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The reduced flushing of lakes is only one of several factors that are degrading water quality in our province. We do little to protect the catchments that supply our water. Increased clearing of land, use of fertilizers and intensity of livestock culture are adding to the water problem by supplying both nutrients and pathogens to our water supplies. The destruction of stream bank vegetation and the draining of wetlands remove natural filters that once kept nutrients, silt and pathogens out of our lakes and streams. Most of the streams, dugouts and shallow wells in agricultural areas of Alberta do not meet provincial water-quality standards for nutrients or fecal coliforms. For example, a recent study revealed that livestock in the catchment of the North Saskatchewan River was polluting Edmonton's water supply with cryptosporidium, a protozoan that causes gastrointestinal illness in humans.

Over-fishing is another cause of water-quality degradation. When predatory species such as lake trout, walleye and northern pike are doing well, lakes are generally in a clear, low-algal phase. Predators effectively control smaller fishes, allowing large populations of invertebrates that filter algae. When predatory species are fished down, as is occurring throughout much of southern Canada, the system flips to a turbid, high-algal phase. The shortage of predators allows small fishes to flourish and overexploit invertebrates, weakening the invertebrates' ability to remove algae.

IN 2002, THE OIL AND GAS INDUSTRY estimated that signing the Kyoto accord on greenhouse gas reductions would cost them $30-billion. But no mention was made of the potential costs to other sectors of failing to sign the accord. It seems reasonable to ask what the economic losses to agriculture, forestry and other sectors might be if we further contribute to global warming by not reducing emissions.

The recent average value of the agriculture industry in Alberta is estimated to be $8-billion. In 1999, the first year of the present drought, farm aid in the province was $292-million. In 2000, it jumped to $750-million, and in 2001 it increased again to $1-billion. Estimates for 2002 are near $1.5-billion. The prognosis for 2003 is still worse. Yet these figures represent a small part of what farmers have actually lost and do not consider the social changes that will result from people abandoning the prairies. And these are real figures, whereas the oil and gas industry estimates are based on worst-case projections.

From 1980 to 2000, the amount of Canadian forest lost to fire was double that of the previous several decades. There are no economic estimates of the value of lost forests, but it is surely many billions of dollars. Fire suppression activities, which cost Canada an average of $560-million per year, do little to decrease the total area burned. Especially in dry years, efforts are largely devoted to saving private property. Some scientists estimate that climate warming could cause the forest fire damage to increase two-fold over the next century.

The costs of maintaining water supplies should also be considered. The region around Humboldt, Saskatchewan, recently built a 193-km pipeline to the South Saskatchewan River to replace their lost groundwater. The pipeline cost $32-million, an economic burden that fell on fewer than 10,000 people. Several communities in southern Alberta have applied to construct similar pipelines to tributaries of the South Saskatchewan, with estimated costs in the $20-million to $30-million range. (The South Saskatchewan is already the most over-utilized large river system in the West, supplying numerous irrigation schemes and several large cities with water. Average midsummer flows below Saskatoon are only about 20 per cent of what they were in the

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early 20th century. If more of its water is taken for communities, industry or irrigation, the river will effectively become a small stream.)

Our decreasing water quality also has economic consequences. To treat the cryptosporidium in its water supply, Edmonton recently had to install UV treatment at one of its water treatment plants. The capital costs alone of installing the new treatment were $10-million.

DROUGHT WILL EVENTUALLY put the lid on the so-called Alberta Advantage if we do nothing to improve our water management. Our rapidly growing industry and human populations are straining our diminishing water supplies. In the southern part of the province, demand is already approaching or even exceeding supply. It is time for Albertans to address the question of how much industry and human population we want. The recent national census indicates explosive population growth for the province. The press greeted this news as a positive sign. But many Albertans live here because they prefer the province's "elbow room" to the crowds of the Ontarios and Californias of the world and because they do not want their activities closely regulated by government. Yet history has shown that population growth is always accompanied by a smaller share of resources for each resident. As more people try to find space for recreation, business, agriculture, housing, air and water, regulation increases.

Some believe that to provide more water we can simply add more dams to rivers or divert waters from the Peace and Athabasca rivers in the north—"as simple as turning on a tap," as one rural Albertan enthusiastically described to me in a recent letter. There are several reasons why this is not a solution. Our northern rivers have already declined in flow by 40 per cent. In the past 30 years declining river flows, resulting from climate warming and the Bennett dam, have caused severe drying of the Peace-Athabasca delta. This has caused considerable damage to wildlife, fisheries, waterfowl habitat and aboriginal livelihood. And much of the remaining water from the northern rivers will be used in the quickly expanding oil sands developments. The costs of dams and diversions have also become prohibitive. Cost-benefit estimates for the recently proposed Meridian Dam on the South Saskatchewan are only 30 cents per dollar invested. Diversions that require more control structures would be even more costly.

It would be more sensible to adopt stringent water conservation practices. Some of these are quite simple and have been used for years in other arid locations. All municipal water use should be metered. The price of water should be very low for basic household needs, so the poor are not penalized. Water rates should increase sharply for more profligate use, to encourage water conservation.

As population and industry grow, more costly conservation measures must be added. New construction should include water-recycling systems, so that "grey" water from sinks and showers is reused for flushing toilets, watering lawns and washing cars. At present, about 95 per cent of the water we use does not need to be treated to drinking-water standards.

More efficient irrigation and farming is required. Spraying water high in the air on hot, dry, windy days wastes half of it. Cultivating crops that are less water-demanding may also be necessary. Some recent feedlots have reduced their water needs to 20 per cent of average use by making relatively simple changes, such as composting wastes rather than flushing them into lagoons. Such practices should be required throughout the livestock industry. Not only do they conserve water but they also help to diminish the quantity of nutrients and pathogens in watercourses.

New legislation should be developed to protect riparian (stream bank) vegetation and wetlands, especially in catchments that supply drinking water. These ecosystems help to recharge groundwaters, maintain surface-water flows in midsummer, and filter out eroded soil, nutrients and pathogens. A failure to protect water supplies will result in higher costs of water treatment and, in many cases, lower water quality. The fish in our lakes also need better protection, to prevent an increase in algae and turbidity.

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These are but a few of the changes we must make if we hope to retain the economies and natural ecosystems of the western prairies and the quality of life that Albertans enjoy. We have thoughtlessly ignored our waters during the development of prairie society in the 20th century. Our water has literally suffered "death by 1,000 cuts" from the effects of extravagant use, poor land management, water pollution and changes to the communities of natural plants and animals. Let us hope that we can respond in time. The matter is urgent.

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